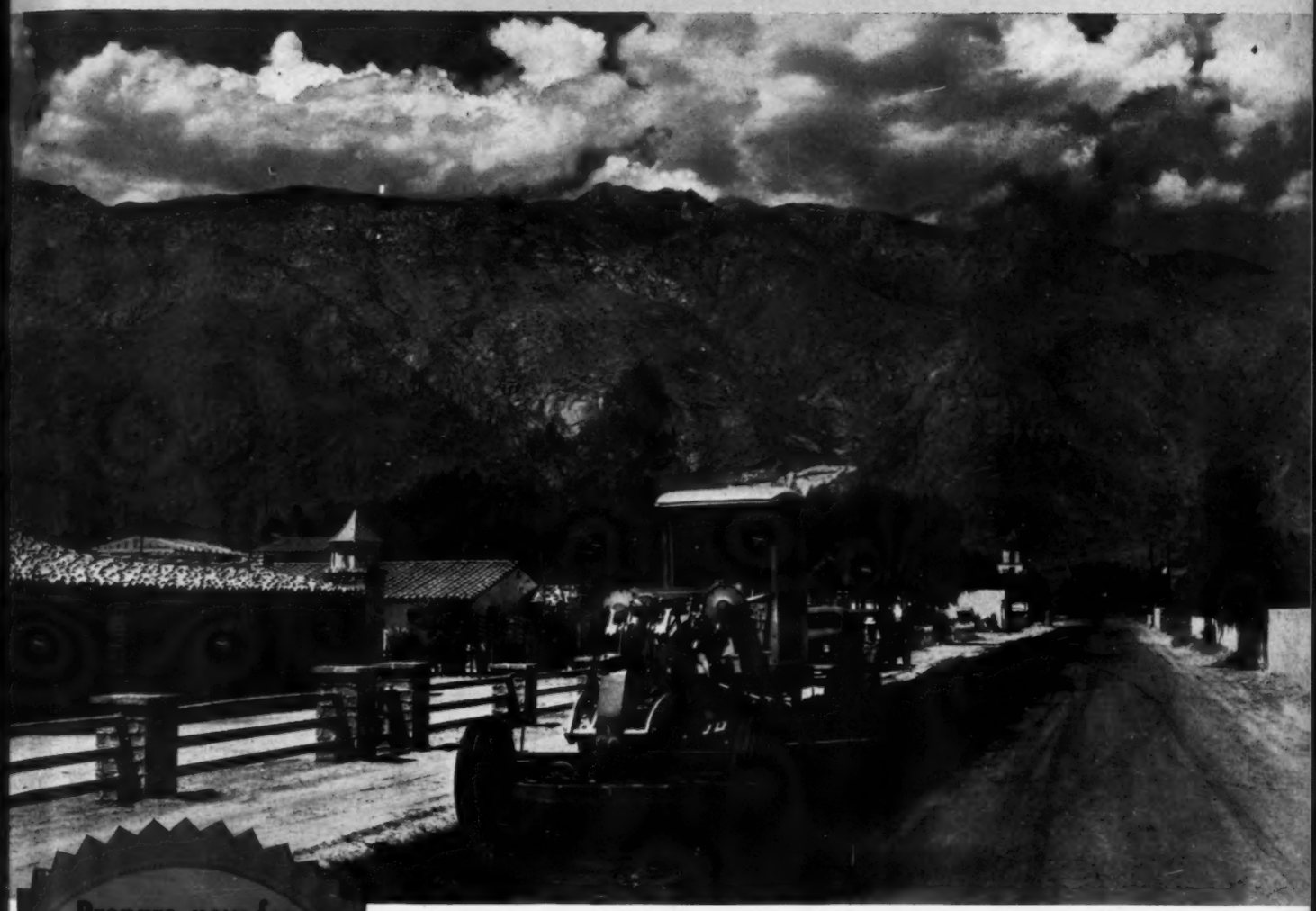
TECHNOLOGY DEPT.

ROADS AND STREETS

JUN 25 1942
DETROIT

JUNE 1942



Adams No. 304 Motor Grader equipped with Timken Bearings. City of Palm Springs, California.

Prepare now for increased road building after Victory. Redesign your equipment to include more Timken Bearings for faster, lower cost performance.

Road building and maintenance machinery equipped with Timken Tapered Roller Bearings is playing a vital role in America's victory effort. Now is the time to prepare your equipment to meet and beat post-victory competition. Give it Timken Bearing speed, economy and endurance at *every* point of friction and hard service.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Adams Equipment Grades Miles of Roads in

ORDNANCE DEPOTS

ABOVE: *Adams Heavy-Duty Motor Graders grading and shaping roads at new ordnance depot.*

BELOW: *Adams Hauling Scraper backsloping ditches and hauling material to stockpiles.*

• IN OUR VAST new ordnance depots the tremendous quantity of ammunition necessary for modern warfare is safely stored in hundreds of segregated, earth-covered "igloos" connected by a veritable network of roads. In the building of these depots Adams equipment plays an important part. . . . Hauling scrapers level ground and cut grades for the scores of miles of connecting roads—moving the earth to stockpiles from which it is later taken to cover the "igloos." . . . Motor graders do the necessary ditching, shaping and final grading. . . . On ordnance depots—and other vital war jobs—dependable, versatile Adams machines are helping contractors to keep on schedule at estimated costs. . . . If your war project involves road building or earth moving see your nearest Adams dealer about needed equipment. He is ready and able to help you.

J. D. ADAMS COMPANY · INDIANAPOLIS, INDIANA

Sales and Service Throughout the World

USE THESE ADAMS MACHINES—Motor Graders in six models, Leaning Wheel Graders, Elevating Graders, Hauling Scrapers, Tamping Rollers, etc.

ON THESE DEFENSE JOBS—Airfields, camps, defense building sites, ammunition dumps, access roads, etc.

ADAMS

ROAD-BUILDING AND EARTH-MOVING EQUIPMENT

Here's the road joint for rush paving jobs!

Have you a vitally-important road job that must be rushed through to completion in the shortest possible time? If so, we suggest that you investigate Bethlehem Road Joints.

These road joints save time in placing, because they come to you all in one piece —completely shop-fabricated. No time is wasted in fitting together and adjusting many parts. Even the dowels are in position, shop-welded to steel spacing bars, parallel and accurately spaced. The fiber filler can be quickly fitted on by one man. You can place a Bethlehem Road Joint in a small fraction of the time it takes to place a joint with a number of parts that have to be assembled on the job.

One or two men can place a Bethlehem Road Joint, anchoring it firmly in place with a few blows on the pins. The sturdy, two-sided base insures that the joint will not tip over when concrete is poured against it or when the finishing machine passes over it, thus permitting even finishing.

Ask the nearest Bethlehem district office for more information about these shop-fabricated, time-saving road joints.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

ROADS AND STREETS

Vol. 85, No. 6 ▾ **June, 1942**

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ROADS AND STREETS

CCA

A magazine devoted to the design, construction, maintenance and operation of highways, streets, bridges, bridge foundations and grade separations; and to the construction and maintenance of airports.

WITH ROADS AND STREETS HAVE BEEN COMBINED GOOD ROADS MAGAZINE AND ENGINEERING & CONTRACTING

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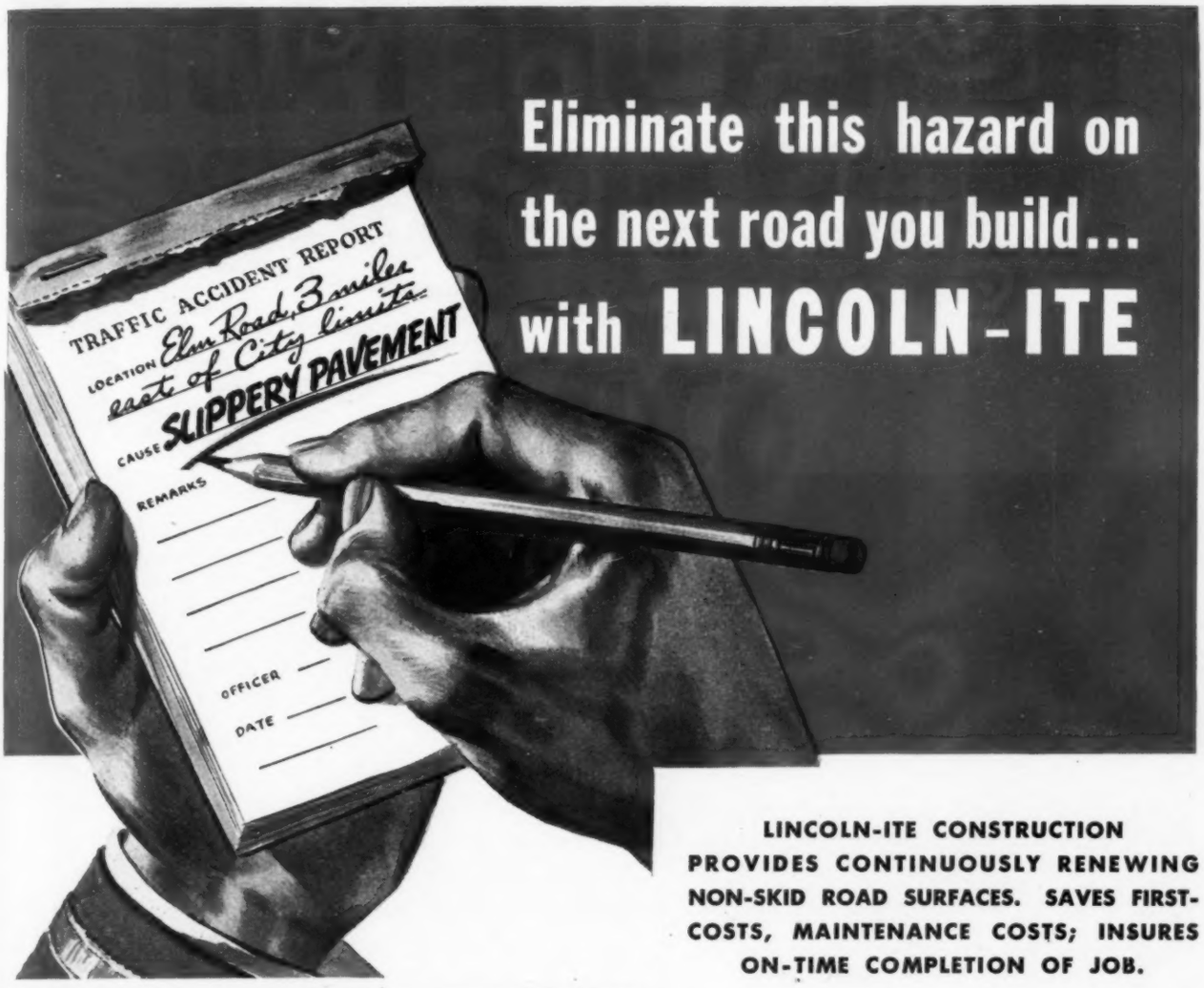


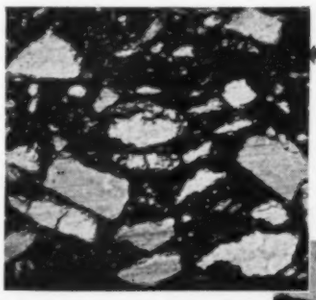
Eliminate this hazard on the next road you build... with LINCOLN-ITE

LINCOLN-ITE CONSTRUCTION PROVIDES CONTINUOUSLY RENEWING NON-SKID ROAD SURFACES. SAVES FIRST-COSTS, MAINTENANCE COSTS; INSURES ON-TIME COMPLETION OF JOB.

"CAUSE — SLIPPERY PAVEMENT" is still being written on too many traffic accident reports. That's why, as a road commissioner or highway engineer, you'll welcome Lincoln-ite . . . the road construction that insures long-lasting non-skid surfaces for roads at surprisingly low cost.

Lincoln-ite's dense-graded aggregate design not only enables you to use local aggregate and equipment . . . but it also means controlled consistency, void control, and safety from skidding by harder, longer-lasting abrasive projections held securely in place by Lincoln-ite's firm, but resilient grip.

Get the facts about Lincoln-ite. Learn how it helps you to build safer roads that last longer, cost less. Write today.



← LINCOLN-ITE NON-SKID SURFACE CONTINUOUSLY RENEWS ITSELF. The dense-graded sand-mastic filling the large voids, presents a sand-paper abrasive surface, that grips the tire and holds skidding to a minimum.

SURFACE-TREATED MACADAM MIX → Bitumen often creeps to the top causing a slick, glazed surface. Roads that were non-skid when laid, soon become hazardous. Open pavement with large voids accelerate weathering, leading to quicker breakdown of surface.

THE OHIO OIL COMPANY, INC.
Findlay, Ohio
PRODUCERS OF PETROLEUM SINCE 1887

LINCOLN-ITE
PULVERIZED PETROLEUM ASPHALT
ASPHALT DIVISION, ROBINSON, ILL.

HERE'S ONE FACT ABOUT OUR SUBS

PASSED

BY CENSOR

U. S. submarines use RPM DELO—a lubricating oil for Diesels unequaled in any other country in the world.

The enemy can take this down in his notebook. He can even sneak a camera shot of it. But it won't do him any good.

Because with all the blueprints and photographs in the world he can't copy the calm, hard-headed skill and heroism of the men in our Navy submarines. He can't duplicate the free spirit and unhampered initiative that invented the submarine—and is going to keep on inventing.

And we're proud to say, for our part, that with all the oil in Asia neither he nor anybody else has anything approaching RPM DELO. And this is another thing he cannot copy.

If, at crucial moments, his rings stick and parts freeze—and he has to put in for overhauls many times as often—it will give us great satisfaction to say: . . . *"So sorry!"*

U. S. Navy submarines use RPM DELO and we're here to say that Uncle Sam has first call—and will continue to have first call—on every precious drop he can use.

Standard Oil Company of California

ORDER RPM DELO FOR YOUR DIESELS

RPM DELO is marketed under the following names:

RPM DELO · Caltex RPM DELO · Kyso RPM DELO
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CONCENTRATE

Ask your Diesel engine manufacturer or distributor for the RPM DELO supplier in your vicinity.

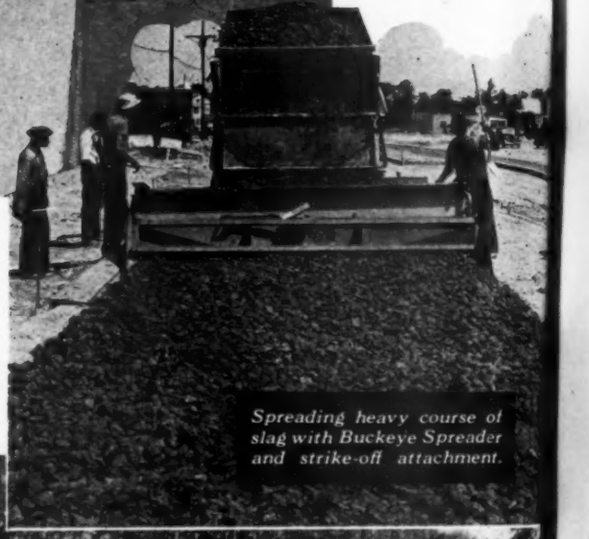
LET'S GO! U.S.A. KEEP 'EM FLYING!

RPM DELO
REG TRADE-MARK
DIESEL ENGINE LUBRICATING OIL

YOU CAN *Handle all kinds of jobs*

Runway construction—huge military airport.

Street work in Minneapolis.



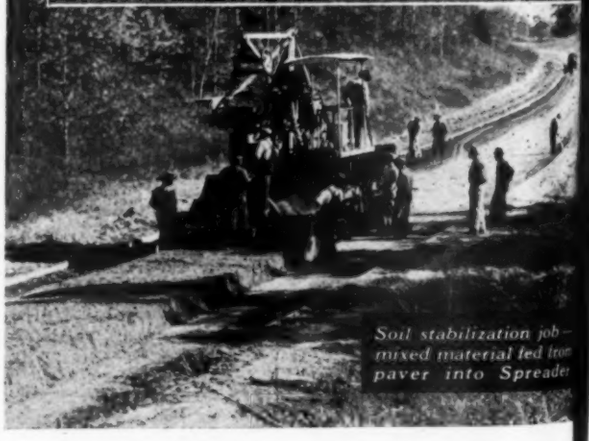
Spreading heavy course of slag with Buckeye Spreader and strike-off attachment.

with a BUCKEYE SPREADER!

ACCURACY plus versatility makes the Buckeye Spreader an ideal machine for maintenance and construction of roads, streets and runways. This machine will handle everything from a fine sprinkle of sand up to a heavy course of rock, and with a strike-off attachment will put down courses up to six inches deep.

Transmission-driven feed roll is synchronized with truck speed and operates forward or reverse. Wheels are well in from end of box to permit spreading close to shoulders or obstruction. Spiral distributor, available when desired, feeds even wet or slightly tacky material to ends of box. Flow stops without dribble by manual control, or automatically when truck stops. These and other construction features that provide as high as 98-99% accuracy described in Buckeye Spreader Bulletin. Write for your copy.

BUCKEYE TRACTION DITCHER COMPANY, Findlay, Ohio



Soil stabilization job—mixed material fed from paver into Spreader.

Built by Buckeye

CONVERTIBLE SHOVELS, TRENCHERS AND BACKFILLERS, TRACTOR EQUIPMENT, R-B FINEGRADERS, ROAD WIDENERS AND SPREADERS

CHECK PAGE 63

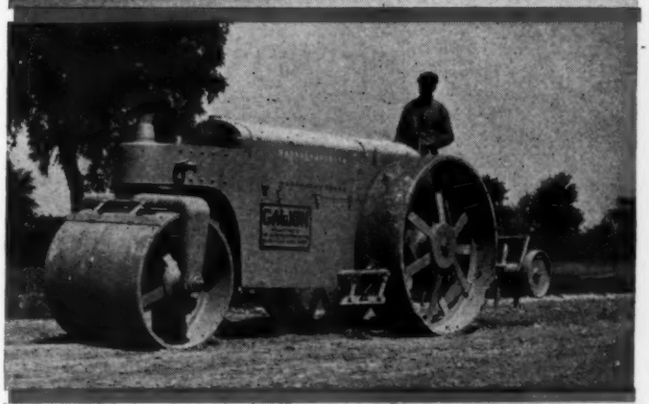
★ Increased housing near Victory plants means more and better roads and streets. This Galion No. 201 motor grader is blading a street preparatory to resurfacing.

★ Next is shown a Galion portable on airport construction, rolling blacktop on runways and aprons.

★ Then a Galion 3-wheel job on a Victory highway. A heavy duty roller with diesel power and hydraulic steering.

★ On a large housing project is a Galion tandem roller, which is an ideal tool for precise compaction and quick maneuvering.

★ At the bottom may be seen a Galion No. 101 motor grader working on a Victory highway out West. More and better roads are necessary and Galion is helping wherever possible.



Galion

ROLLERS—GRADERS SPREADERS

"WORKING STEADILY" and "Helping to build" are as synonymous with the name Galion, as is mechanical efficiency in Galion road machinery. No matter where you go today . . . what kind of Victory project it is . . . there you'll find some piece of Galion road machinery hard at it hour after hour.

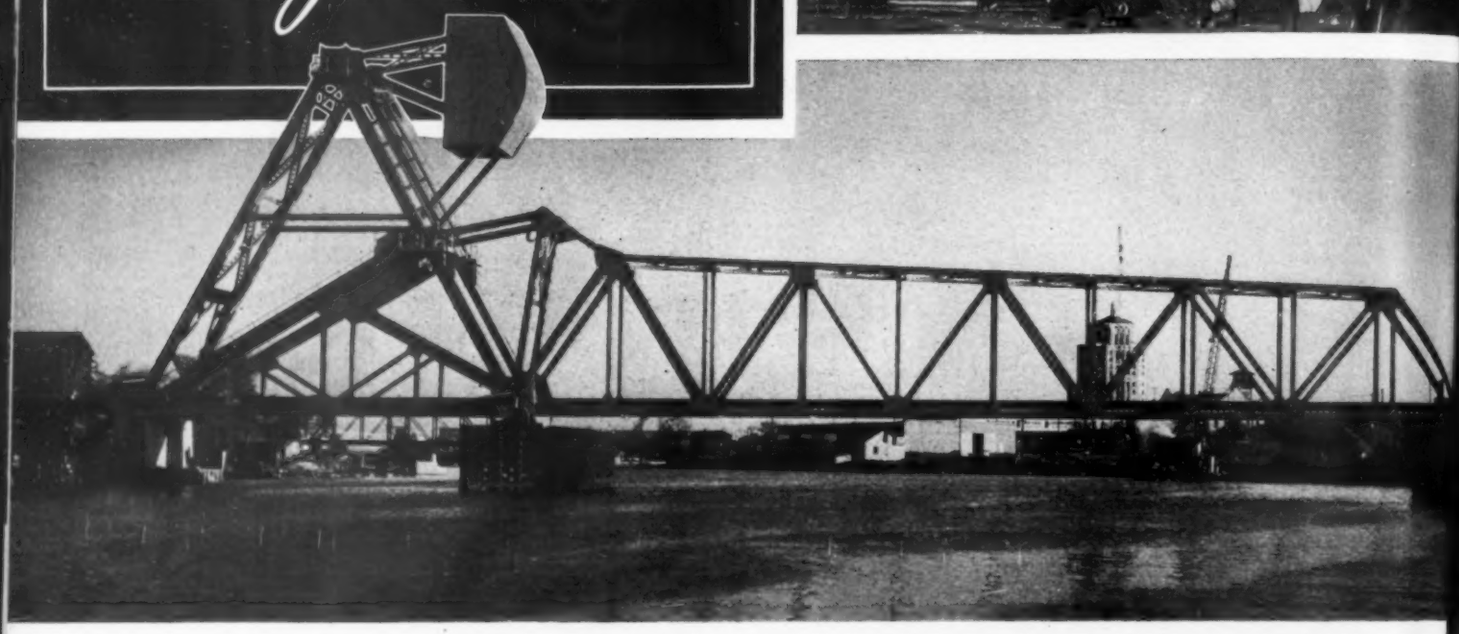
Rollers, motor graders and spreaders . . . all designed to provide the utmost in performance and the ability to get that rush job completed in record time. Like these versatile units, we too must bear down . . . giving freely of our time and money . . . the sooner we get this war business over the better. Let's go—and go faster.

THE GALION IRON WORKS & MFG. CO.

Main Office and Works: Galion, Ohio

CONNECTING LINKS THAT HELP TO CLEAR THE WAY

for faster war transportation



THE ACCELERATING TEMPO OF WAR TRAFFIC over America's highways, railroads and waterways has placed new importance on bridges as expediters of rapid movement. These two bridges typify the strategic roles now played by many spans constructed by American Bridge Company. Though completed recently, in their short terms of service they have made an inestimable contribution to the war effort by speeding and integrating traffic over key routes.

THE 322-FOOT BASCULE BRIDGE, shown directly above, is an important link in a rail network serving industrial Texas. It exemplifies the kind of engineering skill that must go into bridges in these critical days. The center pier of the former swing span split the Neches River into two narrow channels. Increased river traffic brought an insistent demand for a single navigation channel at least 200 feet wide. The new bridge accomplished this successfully. It was erected and the old span dismantled without disrupting train movements, except for an 11-hour interval. Now, rail traffic moves faster because the bridge can be raised and lowered in a fraction of the time required to operate the old swing span. And river traffic conditions are greatly improved by the wider channel.

WAR TRANSPORT IS SPEEDIER to east coast shipping points because of the new 2004-foot Passaic River lift-span bridge, shown at the top. Delays to the movement of motor traffic on N. J. Route 25 are greatly reduced. The high-level lift span, having a vertical clearance of 40 feet when closed, requires only a fifth as many openings as were formerly necessitated by the old low-level drawbridge, and openings require less time. This bridge was chosen by the American Institute of Steel Construction as the most outstanding in the movable-bridge group opened to traffic in 1941.

IT MEANS MUCH TO US to know that hundreds of American Bridge-built spans throughout the country are helping to clear the way for faster war transportation. Today, and until Victory is won, our entire resources of equipment, engineering talent, and specialized "know how" are pledged to projects directly essential to the war.

AMERICAN BRIDGE COMPANY

General Offices, Frick Building, Pittsburgh, Pa.

Baltimore · Boston · Chicago · Cincinnati · Cleveland · Denver · Detroit · Duluth
Minneapolis · New York · Philadelphia · St. Louis

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

"Without an overhaul job since October, 1938."

—from letter dated January 19, 1942

WHEN SHANNAHAN BROTHERS, Railroad and General Contractors, say that a shovel "has been subjected to extremely difficult work," it means something.

Yet this one has been used in their Quarry at West Riverside, California, since October 1938 "without an overhaul job of any nature."

Shannahan shovels use Macmillian RING-FREE exclusively!

The motor shown "has the original rings and bearings," they write us.

And read why they say they do not hesitate to recommend RING-FREE "for use in any heavy equipment." It's because:

"We have found through experience that our repair and overhaul bills are practically nil."

What RING-FREE has done for others, it can do for you. Write us!

SHANNAHAN BROS., Inc.

Gentlemen:-

Very truly yours,

SHANNAHAN BROS., INC.

By

MACMILLAN
RING-FREE
MOTOR OIL

MACMILLAN PETROLEUM CORPORATION
50 W. 50th Street, New York • 624 South Michigan Avenue, Chicago
530 West 6th Street, Los Angeles

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Macmillan Petroleum Corp.

Move to BIGGER OUTPUT with a BUCYRUS ERIE

The ⅜-yard 10-B travels up to 4¼ m.p.h. on its own cats; steers at full speed in sharp turns or sweeping curves, as easily as a tractor. Low ground-bearing pressure, low center of gravity, unusual propelling power, and easy steering control are combined so you can take the 10-B over soft or rough ground, through narrow openings, up steep grades. Here are some of the features that cut 10-B moving time and consequently increase digging time:

1. High-speed friction-clutch steering. Steers on the move, exactly like a tractor.
2. Box-section side frames; strength for rough travel, sharp turns.
3. Heat-treated coreless treads; uniform metal section, long life.
4. Narrow self-cleaning rollers; permit belt to flex and follow ground variations.
5. Quick, sure belt adjustment.
6. Positive digging brakes.
7. Bevel propel gears enclosed in oil.
8. Dragline bearing pressures as low as 5.1 pounds per square inch.

For mobility, for long life, for sheer output capacity, the 10-B leads its class. If you need a larger machine, you can choose from Bucyrus-Erie's complete line and be sure you're getting an excavator that will spend the least time moving; the most time digging.

KEEP MOBILE WITH A BUCYRUS-ERIE

Bucyrus-Erie

SOUTH MILWAUKEE, WISCONSIN

Why HAZARD LAY-SET *Preformed* Lasts So Much Longer

Wires of Preformed Rope are at Rest

The wires and strands of a PREFORMED wire rope are not under such internal stress. They are at rest, ready to bend in the direction required of them without offering opposition further than resistance in the metal itself. Thus, it is easily seen that, given two ropes of the same diameter, construction and grade, the preformed rope will be more easily flexed around the sheave or drum. By the same reasoning, it is possible for a PREFORMED rope of higher grade or with wires of larger diameter to be flexed or bent with the same force required to bend a non-preformed wire rope of smaller or softer wires.

AND THEREBY CONSERVES STEEL FOR THE NATION

Preforming has added to the service of wire rope to all industry

PAGE 89

Here in a few words the "MODERN WIRE ROPE DIGEST," America's No. 1 authority on wire rope, explains *why* Hazard LAY-SET lasts so much longer—gives so much better service—than ordinary non-preformed wire rope. Proper preforming gives LAY-SET amazing fatigue resistance; kink-resisting flexibility; makes it easier and faster to reeve; safer to handle. LAY-SET PREFORMED is the greater-dollar-value rope.

LAY-SET PREFORMED is backed by 96 years of rope-making experience and by a company that has clung so tenaciously to quality materials, manufacture and service that it has on its books many firms who have used Hazard ropes continuously for 40, 50 and 60 years. All Hazard ropes identified by the Green Strand are made of Improved Plow Steel.

GREEN SIGNIFIES SAFETY

HAZARD WIRE ROPE DIVISION

Wilkes-Barre, Pa., Atlanta, Chicago, Denver, Fort Worth, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, Tacoma

AMERICAN CHAIN & CABLE COMPANY, Inc.

BRIDGEPORT, CONN.

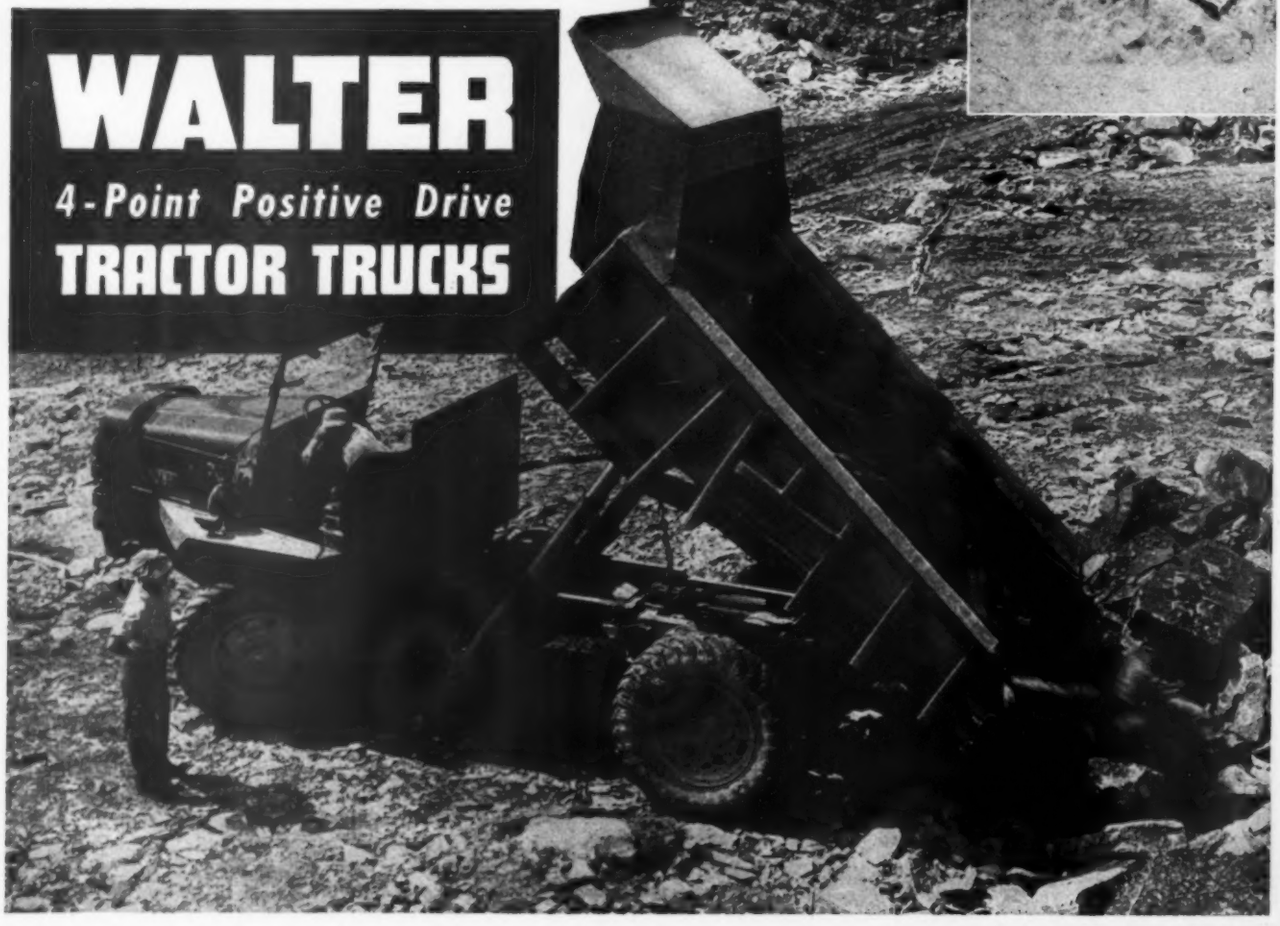
HAZARD LAY-SET *Preformed* WIRE ROPE

Built for Battle!

● The WALTER TRACTOR TRUCK was never designed for smooth highways, easy grades and moderate loads. Walter Four-Point Positive Drive, with automatic lock differentials, suspended double reduction drive and tractor-type transmission, fit it for snow removal and gruelling off-the-road work. Smashing heavy snowdrifts, handling the toughest jobs of road building and maintenance, hauling artillery over broken terrain, pulling enormous trailer loads in coal and ore mining are just a few of its daily tasks. Where loads are heaviest and roads bad — there you'll find WALTER TRACTOR TRUCKS setting new performance records, in all kinds of weather!

WALTER MOTOR TRUCK CO.
1001-19 Irving Ave. • Ridgewood, Queens, L. I., N. Y.

WALTER
4-Point Positive Drive
TRACTOR TRUCKS



Precious Power for the WAR EFFORT

Harnessing the turbulent waters of the Nation for industrial enterprise has proven to be a masterful stroke of ingenuity and foresight. Strategically located Grand Coulee, TVA, Boulder, Seminole, Bonneville, Fort Peck, and many other dams, are contributing tremendously in providing precious power for the war effort. Marion shovels played a real part in the building of these important power projects—just as they are doing today in keeping the output of mines flowing at top speed—and construction ahead of schedule.

THE MARION STEAM SHOVEL COMPANY
MARION, OHIO, U. S. A.

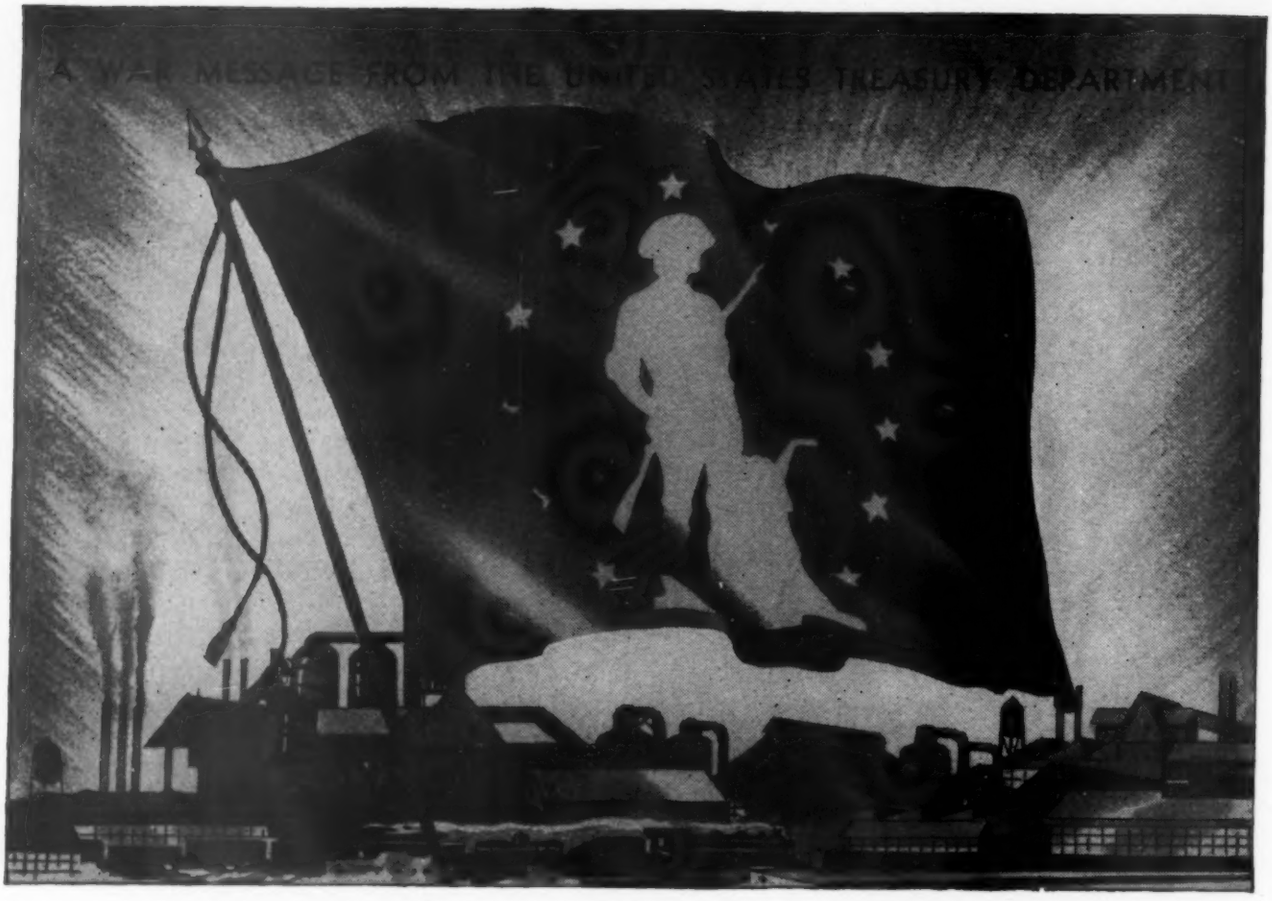
Offices in all principal cities

Serving industry since 1884

MARION

SHOVELS • DRAGLINES • CLAMSHELLS
CRANES • PULL-SHOVELS • WALKERS

Gasoline — Diesel — Electric — ¾ cubic yard to 35 cubic yards



Next to the Stars and Stripes . . .

AS PROUD A FLAG AS INDUSTRY CAN FLY

Signifying 90 Percent or More Employee Participation in the Pay-Roll Savings Plan

IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly,* every pay day, through the systematic purchase of U. S. War Bonds.

You don't need to be engaged in war production activity to fly this flag. Any patriotic firm can qualify and make a vital contribution to Victory by making the Pay-Roll Savings Plan available to its employees, and by securing 90 percent or more employee participation. Then notify your State Defense Savings Staff Administrator that you have reached the goal. He will tell you how you may obtain your flag.

If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

Make Every Pay Day "Bond Day"

U. S. **WAR Bonds ★ Stamps**

This Space is a Contribution to Victory by ROADS AND STREETS

U. S. GOVERNMENT PRINTING OFFICE 16—27879-1

Form No. DSS-BP-4

YOU can help build more War Supplies

BY ITS VERY NATURE, the dirt-moving business has always been a race against time, a battle against the elements. Now it is necessary to speed-up even more. Rush your contracts through ahead of schedule! The sooner you finish your project, the sooner its final objective can be realized — the more planes, ships, guns . . . machines, parts and supplies there will be! There are many ways of cutting corners . . . clipping seconds off this job, minutes off that one. Your job short cuts, and ways of making your machines last longer, will help the other fellow help his country . . . likewise, his ideas will help you. Why not exchange this information? Send your suggestions to us. To encourage this, we will pay for those used in our ads. Start 'em coming . . . NOW!

PROVEN JOB SHORT CUTS

Use your reserve tractors as pushers. The pusher-loading method enables you to haul more material per trip, cut loading time ½ to ⅓ and reduce the wear and tear on your machines.

• • •

Load your scrapers downhill, wherever possible . . . it's quicker and much easier on your equipment.

• • •

Do your culvert pipe excavating with your 2-wheel scraper and 2-Cycle Diesel tractor . . . or with a Hough Shovel and WM tractor. Either machine will finish up the job in a fraction of usual time.

• • •

Handle your clearing with Allis-Chalmers tractors equipped with Carco winches. It's simple to run a winch line into an inaccessible area, attach the cable, and pull out the trees and stumps.

• • •

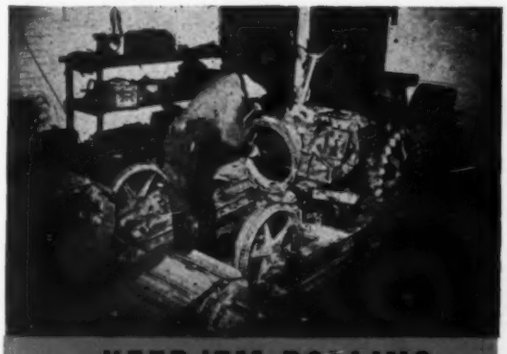
When finishing, windrow your loose rock with your Model AD Motor Grader or Leaning Frame Grader, then pick it up with your four-wheel Gar Wood scraper. Does a fast, clean job.

WIN $5

Allis-Chalmers Will Pay $5 For Each Suggestion Accepted For Publication In Future Advertisements . . . on

1. Job Short Cuts (like examples you have just read.)
2. How To Make Tractors and Graders Last Longer.

Use as many words as necessary to tell your story. Illustrate, if you wish. Awards will be based on the value of the suggestions, not on literary style. Everybody eligible.



KEEP 'EM ROLLING

Keep your equipment in first-class condition. Your Allis-Chalmers dealer is fully equipped to give you A-1 service on repairs, parts, rebuilding jobs. He may have good buys on used machines, too. Keep in touch with him.

INVEST IN VICTORY . . . BUY WAR SAVINGS BONDS AND STAMPS

ALLIS-CHALMERS
TRACTOR DIVISION · MILWAUKEE, U.S.A.

Power for Victory!

Tough as the HIDE of a HELL-BUGGY!

—and there's a reason, for Owen Heavy Duty Excavating Buckets like modern war tanks, are designed and built for tough assignments and are always dependable under the most difficult operating conditions. Quality materials used in construction throughout, assure long service life with a minimum of wear.

THE OWEN BUCKET COMPANY
6070 BREAKWATER AVENUE CLEVELAND, OHIO
Branches: New York, Philadelphia, Chicago, Berkeley, Cal.

OWEN BUCKETS

A MOUTHFUL AT EVERY BITE

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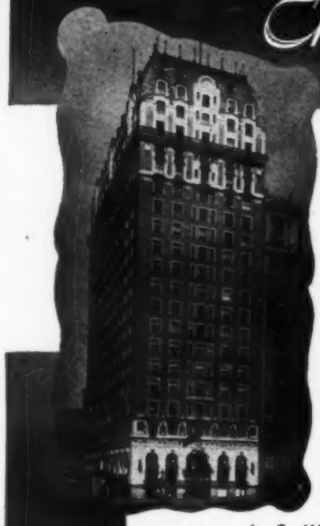

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By V. J. Brown
Publishing Director
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Senior Highway Engineer,
U. S. Public Roads Administration
C. A. Hogentogler, Jr.
Research Engineer,
George Washington University
Frank H. Newman, Jr.
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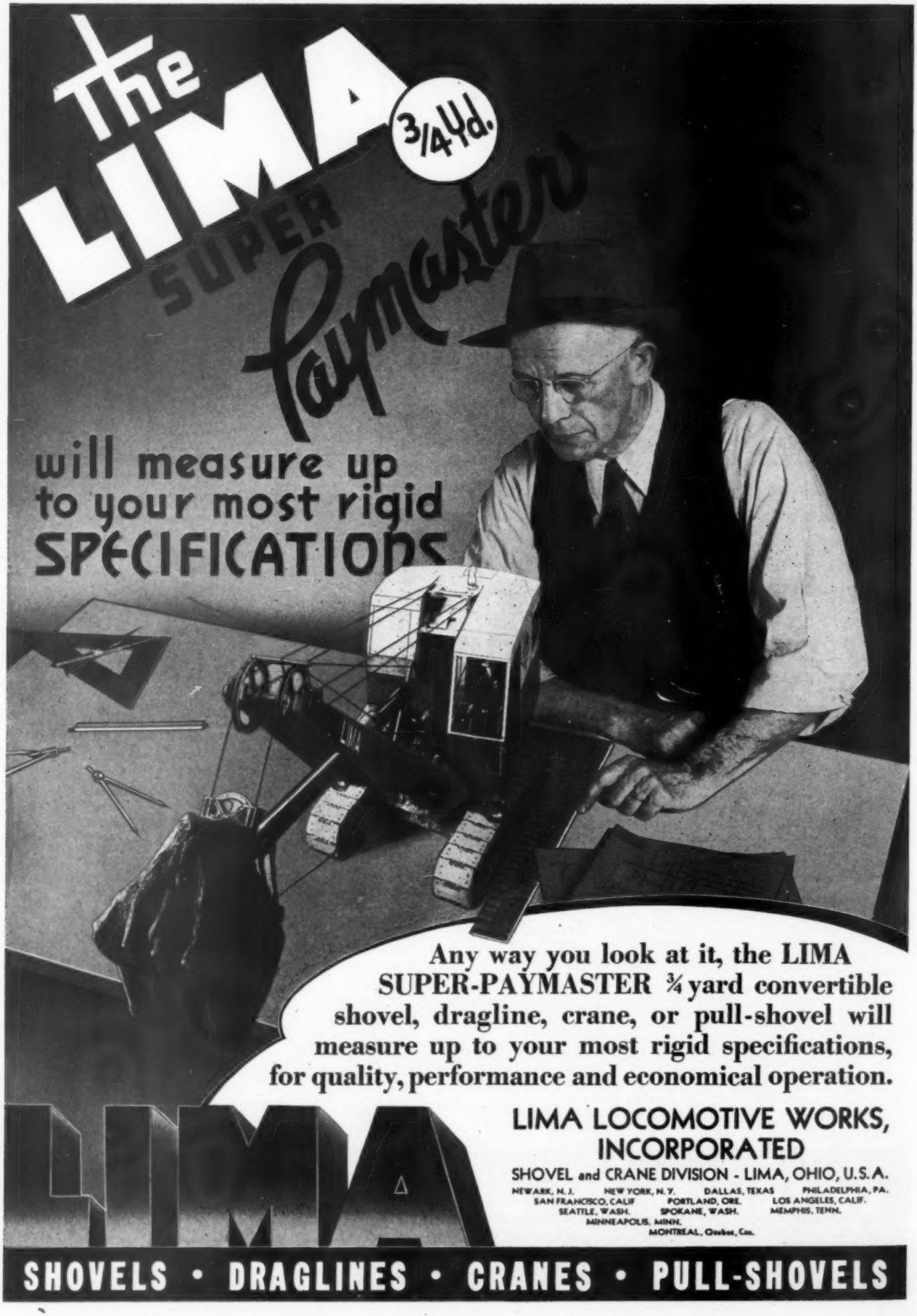

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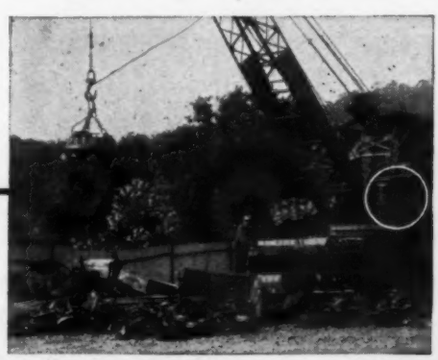

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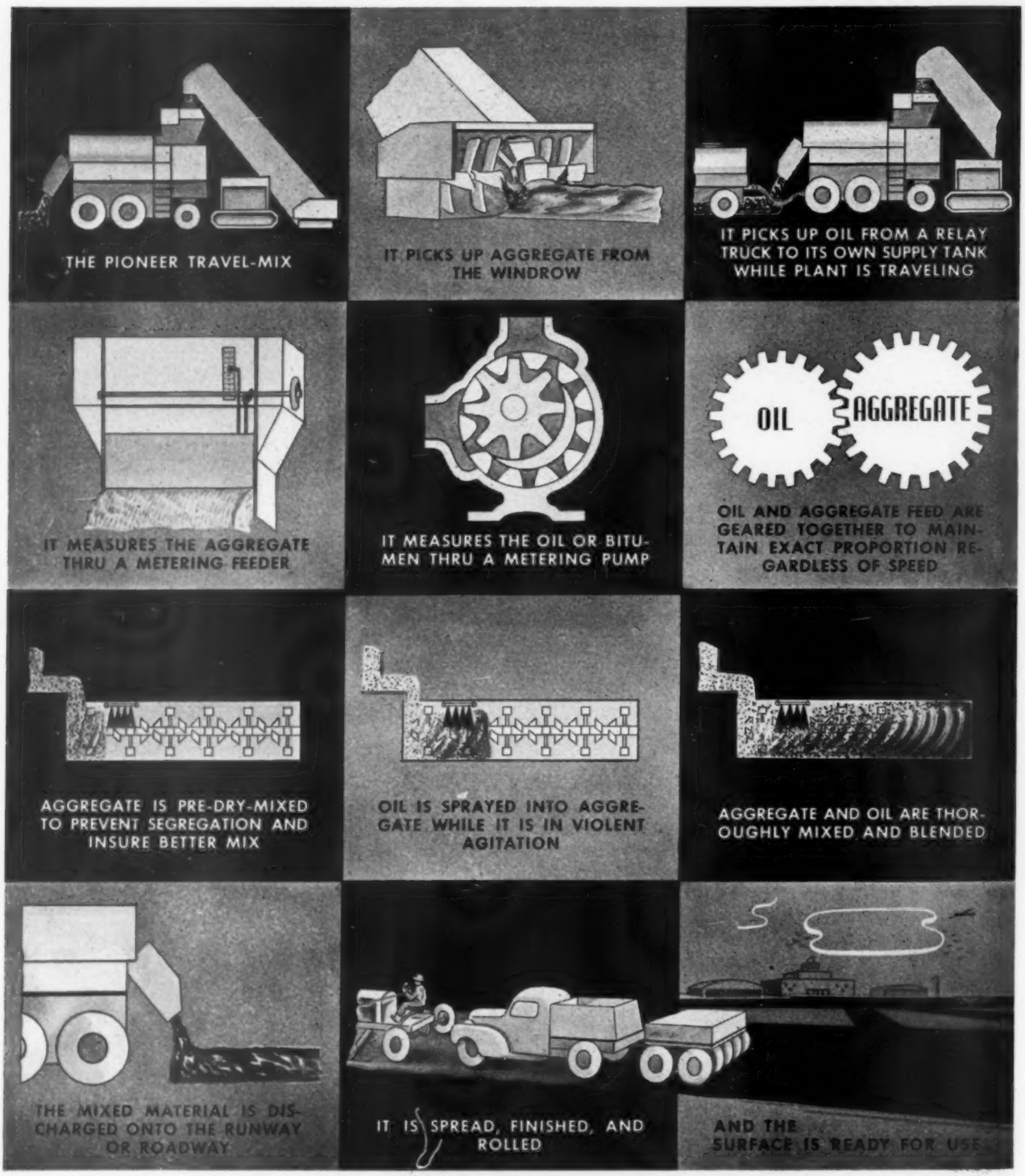
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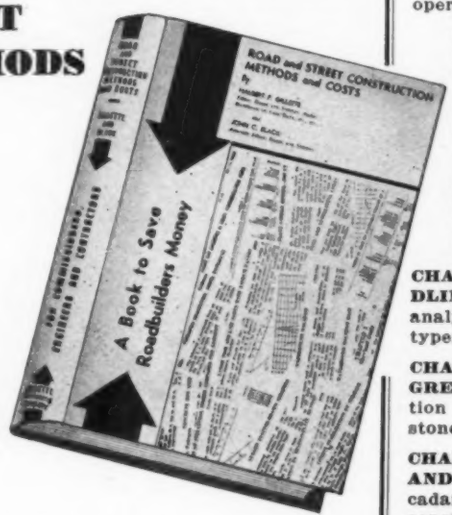

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CHAP. 1. INTRODUCTION — Brief discussion of construction costs, prices, profits, etc.

CHAP. 2. COST INDEXES—Important indexes—their uses and limitations.

CHAP. 3. OVERHEAD COSTS—Contractors' overheads and public overheads compared.

CHAP. 4. ENGINEERING — Data from states, cities and other sources.

CHAP. 5. RIGHT-OF-WAY—Records and discussions.

CHAP. 6. EQUIPMENT — Rental, ownership and expense schedules in full detail; followed by records of operating and maintenance costs.

CHAP. 7. LABOR — Schedules, records and comparisons of wage rates, etc.

CHAP. 8. CLEARING AND GRUBBING — Records of work by various methods.

CHAP. 9. GRADING — Records and analyses of operations with varied types of machines under various conditions.

CHAP. 10. HAULING AND HANDLING MATERIALS — Records and analyses of operations with various types of equipment.

CHAP. 11. PRODUCTION OF AGGREGATES—Data on the production of sand, gravel, and crushed stone.

CHAP. 12. UNTREATED BASES AND SURFACES—Waterbound macadam, crushed rock and gravel construction.

CHAP. 13. STABILIZATION OF BASES AND SURFACES—Stabilization with calcium chloride, portland cement, asphalt and tar.

CHAP. 14. BITUMINOUS SURFACES AND BASES—Details and analyses of costs of various types of construction.

CHAP. 15. CONCRETE SURFACES AND BASES—Details and analyses of costs of various types of construction.

CHAP. 16. BRICK PAVEMENTS—Records from various cities and states.

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ROADS AND STREETS

June, 1942, Vol. 85, No. 6

Skillful Use of Construction Equipment on Heavy Roadwork

By **E. B. BAIL**
Materials Engineer
New Mexico State Highway Department

SUPPOSE you are a Contractor. Suppose you had bid on a job, and unexpectedly got it, but found you had left a lot more money "on the table" than the law of averages for this sort of gambling called for. Right away, you would go over your bid figures to see where you wrote down 25 cents for solid rock when you meant to write down $2.50, or three cents for reinforcing steel when you meant to bid six cents or twelve cents for unclassified excavation where you were sure you had written sixteen cents. Those things happen to the best regulated contractor and you know that the first thing a good contractor does, when he is awarded a job, is to go back over his figures and see where he made his mistake.

Suppose, now, you have gone back over your figures, hunted from hell to breakfast for the scraps of paper you used to cut down your first figure when you remembered that Smith generally bid a little lower on this and Jones always bid a little lower on that. Suppose you found all those scraps of paper and you and your superintendent looked them all over again and maybe the job didn't look so good, now that you had it, as it did while you were trying to get it, but, still and all it might be done for a little more than you bid for it and anyway you had to keep your chin up and tell your grinning competitors that "she was a good job when you bid her and she was still a good job." The state gave you 200 days to do the job but you knew you had to do it in less time than that for your own peace of mind. You took another look at your list of equipment available, and figured what you could steal from some of the other jobs you had going on, and it stacked up something like what is given at the end of this article.

Suppose now that you were Henry Thygesen, of Henry Thygesen, Inc., Korber Bldg., Albuquerque, New Mexico, and you had just been awarded the contract to construct New Mexico FAP 21-D. Your contract calls for the building of 87 drainage structures, including one reinforced concrete bridge, some 3600 cubic yards of concrete, and moving 842,000 yards of unclassified excavation. At this point a short description of the route might be of interest to your friends who may have occasion to ride over your finished job.

Where Located

The job is a link in the federal aid system of New Mexico on U.S. Route 64, between Santa Fe and Taos. The old road which this replaces was a section of the old military highway, known locally as El Camino Militar which was built by Army engineers in the last half of the Nineteenth Century. Like its predecessor the new road contests with the river for possession of the bottom of the Rio Grande Canyon. It has been a case of give and take with the river, the latter endeavoring to do the taking and the engineer resorting to all the artifices of his trade to prevent it.

It is seldom that the engineer who makes the location survey becomes, later, the man in charge of construction. This is one of the rare instances. T. G. Brown, was Chief-of-party and in direct charge of the location, and was later selected to act as Project Engineer in charge of construction.

Practice followed on location was that commonly used by this department in heavy country. A former location was used as the base for a very complete contour map on which a projection was made. With projec-

Fig. 1.—Cut on high side was 99 ft. Contractor worked material down to 40 ft. from profile grade before moving in power shovel

Fig. 2.—Looking north, or upstream, from Sta. 461 gives a fair idea of the topography through which the line runs. The old road is at the left. Photo credit New Mexico Tourist Bureau

tion in hand a very satisfactory line was fitted to the ground.

The total length of the project is 8.158 miles. There are 27 curves on the project. The sharpest is 4 deg. 30 min. and only one of this degree. There is one 4 deg. curve; the rest are 3 deg. and under. Maximum grade is 6 percent and 3200 feet of this severity and that scattered in short sections over the job. The picture looking north, or upstream from Sta. 461, figure 2, gives a fair idea of the topography through which the line runs. Sight distances conform to latest requirements.

Beginning at a point about five miles from the north end the new road bed lies on a shelf which is nothing more than a bench cut in the talus slide coming down from the high rock slopes on the east, or right, of the line. Before man took the notion to try to inch in on the Rio Grande these talus slides had their toes in the river. The existing slope of this talus varies, depending on the composition of the slide material, but in all cases is flatter than the man-made back slope, figure 3. Placing the roadway in such a position looks like a gamble, and it is to the extent that the examining engineers who approved this location assumed that internal friction would hold the talus in its present position. To date, nineteen months after its completion no serious slides have occurred. Nevertheless no location engineer will look at this picture without mentally questioning why the road was not built on the opposite side, away from the high bluffs and talus slides. It may be stated here that a preliminary line was run along the west side but decision was finally made in favor of the east or present location because it would better serve certain villages and facilities already established along the old road. Placing the new road on this bench cut in the talus slope introduced another undesirable construction feature, which is well illustrated in figure 4, showing a 6 ft. by 4 ft. concrete box culvert at Sta. 678. This box, in the immediate foreground is on a 1:1 slope; the distant one is on a 1½: 1 slope and is 133 ft. long and is also 6 ft. by 4 ft. These boxes are set on these steep grades to make as certain as is humanly possible that they will carry the rush of slide rock and boulders coming down the waterways in the talus during short but heavy summer showers.

To anyone familiar with the seasonal variation in the flow of New Mexico streams, the scene, figure 4, suggests that on the day this picture was taken the Rio Grande was at low-water stage. It further reveals that at high-water stage, the river would be pretty well backed up in these particular culverts. Admitting that condition does exist at flood stage in the Rio Grande, it may logically be asked what will happen if a heavy rain should occur, bringing down a mixture of slide rock, boulders and water and loading it into these steep boxes at one end while the Rio Grande is backing water up the other end. So far no demonstration of this sort has been given. Flood season in the Rio Grande begins about May first to tenth and usually ends about July first, while the season of heavy summer rains (and some of these rains assume cloud-burst proportions) is from July first to September 30. The problem in hydraulics is an interesting one and resolves itself into this: Will the load of debris and water coming down at 1:1 slope be checked by eight to ten feet of water backed up at the outlet and so be slowed down enough to cause the box to choke?

That the location engineer must have a highly developed bump of guessing is again brought out by the view, figure 3. Imagine a good heavy

Fig. 3.—Looking north from Sta. 607. Curve is 4 degrees. New Mexico type of guard fence is shown

rain falling on those slopes and the hundreds of acres at their summits. As a basis for estimating the area of culvert openings the New Mexico Highway Department uses Talbot's formula, $A = C \sqrt[4]{M^3}$ where A = waterway necessary in square feet, M = area drained in acres, and C = a coefficient. C is commonly set at 1/5 for flat country, 1/3 for rolling land and 1 for steep, mountainous areas. To get a reasonably accurate measurement of the drainage areas for structures in the kind of country shown involved a lot of hard, painstaking field work to insure that no blank spaces were left in the drainage net and to be certain, as well, that there should be no overlapping of areas. When the drainage net was finally completed, it became a matter of interpreting the varying conditions such as approach slope and expectancy of rock flow. It is true that the formula is merely a guide, and in the end there is no substitute for sound engineering judgment backed by long experience. New Mexico's Highway Department is fortunate in having a bridge engineer who possesses those so necessary qualifications. As finally designed, the area of waterway was based on doubling the drainage areas and giving C a value of 1 in Talbot's formula. No severe rains have fallen on this drainage net since completion of construction and the competence of the design assumptions has yet to be tested.

Contractor's Method of Attack

The call for bids stipulated that the work should be completed within 200 days but Thygesen planned his operations to get the job done in six months. To get the most out of a construction organization requires a high degree of executive ability comparable to that required of a combat engineer regiment Colonel in time of war, and beyond doubt our engineer service regiments would be in the best hands possible if commanded by men who were construction superintendents in private life.

Provision for Traffic.—The new construction crosses and recrosses the old road and for considerable distances lies directly on it. The most favorable condition so far as detours were concerned is shown by figure 2; the old road is on the left. At this point it was possible to construct a detour about 1500 feet long which served throughout the construction period. Traffic is not heavy on this route, averaging very close to 500 vehicles daily, but when each cut has to be completely cleaned up as the work progresses in order that cars may go through the problem becomes complicated.

Fig. 4.—Showing a bulldozer starting a channel change. The culverts shown are discussed in the text. Photo credit New Mexico State Tourist Bureau

Pioneer Work. — Construction was started at the south end of the five mile canyon section. A profile of this section between stations 405 and 495 is shown by figure 5. A considerable part of this is side-hill work; the centerline profile scarcely gives a picture of the steep side slopes. Pioneer work was started with two large bulldozers. Picture taken at Sta. 489, figure 6, shows this versatile piece of equipment at work. The slope is steep—see man standing on slope above bulldozer. Probably no single type of construction equipment has done as much to speed up heavy grading work, and by the same token reduce construction costs, as has this combination of tractor and dozer.

In operation the dozers pushed the material as far down the slope as possible in order to cut down the number of lifts the shovels would have to make. As they brought the slopes down the skillful operators on these dozers practically did the fin-

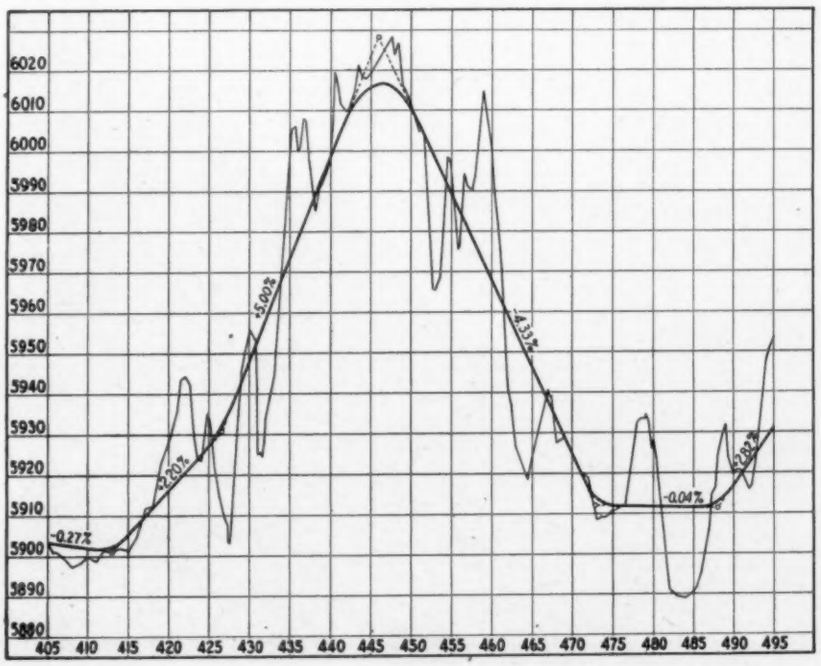


Fig. 5.—Profile of a section of the road. This profile is insufficient to visualize the heavy side hill cutting required

ishing; looking at a profile of one of these long, steep slopes, the contour resembled the teeth of a saw. Hand labor trimmed off the points of the teeth and the slope was finished.

When the cuts had been pioneered the shovels were moved in and the material was loaded into the Koehring dumptors and delivered to adjacent embankments. An example of the teamwork of shovels, dumptors and dozers is well illustrated in the picture taken at Sta. 527, figure 7. In the foreground is a Lima 2½-yard shovel loading into a Koehring dumptor. Between loads the crawler Tractor with its dozer attachment darts in and out smoothing out ruts and shoving spill-overs out of the way. Note that the dozer has ironed out the truck runway, an item that many contractors overlook, to their own cost, is this care for the road their equipment must move over. Care of construction road pays dividends in less wear and tear. Farther up the canyon is a 1½-yard shovel also loading dumptors. There is another crawler tractor with dozer with this outfit. In other words each outfit consists of a loading unit, a hauling unit and a servicing unit. Army engineers take note!

This outfit was equipped to move muck and did it to the tune of 5000 cubic yards per working day. The speed and maneuverability of these Koehring dumptors has to be seen to be appreciated.

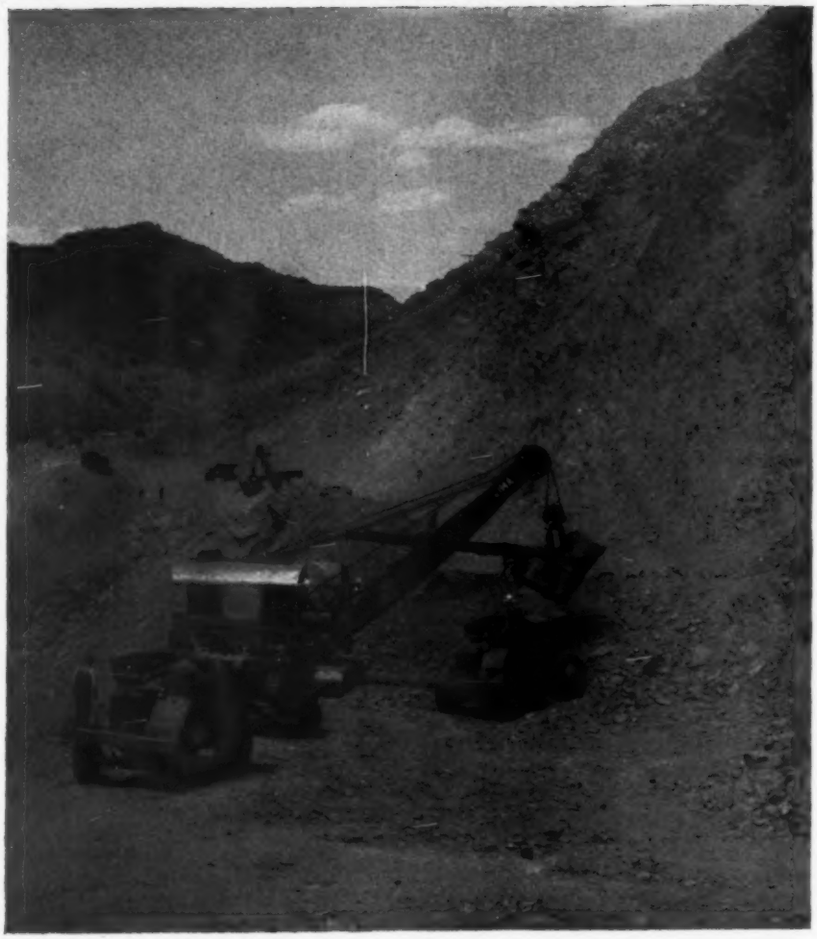


Fig. 7.—Teamwork of shovel and dozer on side hill cut; dozer is just out of view. It cleans up spill and smooths driveways. Photo credit New Mexico State Tourist Bureau

In the meantime there was the matter of placing 3600 cubic yards of concrete in eighty-seven separate structures, ranging in size from 4 ft. by 4 ft. to triple 10 ft. by 10 ft. When you consider that most of these structures were to stand on their heads, as it were, and that in many cases detours had to be carried over them, the difficulties involved in constructing them may be imagined. If the grading operations were to function one hundred percent the concrete work could not be less. This part of the job was sub-contracted to E. M. Silver. His ability to keep out of the way of the daily grading output of 5,000 yards was an achievement in itself. On some types of construction the pouring of 3,600 yards of concrete is only a fair day's work, but divide that amount into 87 separate structures, scattered over 8½ miles, built on slopes of from 3:1 to 1:1, keeping barely one jump ahead of a shovel outfit, and you have a good job for a good man.

Fig. 6.—Pioneering a cut at the Sta. 489. Old road at left had to be kept open for traffic. Photo credit New Mexico State Tourist Bureau

Drilling and Shooting.—From Sta. 450 to the north end of the job the work was entirely in either slide rock or rock-in-place. Thus about 42 per cent could be classed as rock excavation. However only about 18 per cent of these cuts required shooting to loosen. The Rio Grande river throughout this section lies in a faulted area. The entire system of rocks along the

Fig. 8.—Wagon drill mounted on a truck raised drill holes in the shattered formation high enough to be effective down to road grade. Portability from one cut to another was greatly increased. Photo credit New Mexico State Tourist Bureau

east side of the river have been uptilted and badly crushed. This condition cut down the amount of shooting. Another factor reducing use of powder was the immense muck moving ability of the dozers as well illustrated by the view of operations in figure 6. The wagon drill mounted on a truck as shown in figure 8, shows an ingenious adaptation of a standard piece of equipment to situations for which it was not primarily designed. The shattered, faulted condition of the rock beds is well shown in this view.

The old time powderman would take one look at that rock formation and say offhand that that kind of drilling and shooting would not be effective in that rock because of its seamy, shattered condition. It must be kept in mind, however, that the job here was merely to take out a slice; had it been a through cut a coyote shot would probably have been advisable. A study of that twisted face of rock might have given reason for the old timer to guess that something might happen right there most any time and something did.

The cut had been roughed through; the original prism had been taken out; there was some trimming left to do but the shovel had moved out. Suddenly the back slope moved out and down, taking with it a 10 x 8 compressor mounted on a truck. In the picture, figure 9, the compressor can be seen peering over the rocks. It was pulled clear and sent back to work after repairs totalling about one-eighth the cost of a new machine, a rugged testimonial to sound construction. Parts of the truck were found but not enough to prevent its being listed a casualty.

Was Cut Too Heavily Shot?

Prior to the slide at Sta. 527 a 10,000 pound shot of 40 per cent gelatin was fired as shown in figure 10. The picture clearly shows the faulted nature of the slope and shows it extending far up the mountain face. There is no question but that this shot set in motion long restrained forces pent up in this unstable formation. It is likely, too, that a much smaller shot would have had the same effect and very likely, had the contractor elected to take out the toe of this formation without any shooting, the slide would have occurred just the same. It is reasonable to assume that the slide was assured when the decision was reached to place the road there.

With the road completely blocked, communications between headquarters and the active north end was cut off. To clear a path for traffic, the bulldozers were promptly put to work. Bucking, shoving, trampling boulders underfoot, on the verge of tipping over half the time, this dogged mixture of plow, engine and worm, got a road over, around and through the slide in a fraction of the time any other device could have done it.

Changing Channel of Rio Grande

At Sta. 629, figure 12, it was necessary to encroach on the river in order to avoid cutting too deeply into the toes of the talus slopes. More room was made for the river by shooting off a projecting rock cliff on the west side (not visible in picture) and moving back large boulders which had rolled down the east slopes and clear across the river. Many of these boulders were used to build a massive toe wall with derrick size rock to protect the toe of the embankment which jutted out in the river. The compressor, drills and powder were taken across the river in a boat. A cableway and a winch was used to drag the huge rocks across the river and place them in the toe wall. The current is very swift at this point, as the white water in the picture shows, and the operation turned out to be a very tedious one.

At Sta. 680 the river was pushed over again in order to keep down the

Fig. 9.—The 10x8 compressor, mounted on a truck was caught in a rock slide. Wrecked compressor only can be seen in the debris

depth of cutting in the talus. At this point there was more room and a channel change, figure 13, was built entirely by tractor dozers.

Few Accidents

Considering the difficulties met with, the contractor suffered remarkably little equipment damage. The picture taken at Sta. 602, figure 14, shows a dumptor reposing at the riverside after a 40-foot drop. The driver joined the birds and lived to drive another day.

Soils Condition

Three distinct types of material are cut by the new road. Beginning at the south end of the project the construction lies in a sand deposit of relatively fine gradation. One hundred percent passes a No. 10 sieve. The deepest cut (99 ft.) on the job is in this material shown at Sta. 292, figure 1. On the west side of the river the Denver & Rio Grande Railway was constructed through miles of this material. The cut slopes were left vertical, and after nearly sixty years they show very little erosion. This soil classifies under the P.R.A. system as an A-2-F. In an endeavor to find out what made this material function as it does, a chemical analysis was made.

COMPOSITION

Silica	94.98 percent
Iron and Aluminum	1.70 percent
Lime as CaO	0.80 percent
Sulphur Trioxide	Trace
Magnesium	Trace
Loss on Ignition	2.36 percent
Total	99.84 percent

The absence of any appreciable amount of cementing material in this sand leads to the conclusion that its present stability is due to its probably having been compacted under the weight of a great depth of sediment which has since been eroded. This postulate is supported by observation of the extensive beds of this same material about one-half mile away, where the thickness of the deposit gradually increases to better than one thousand feet.

In a little less than a thousand feet this highly desirable material disappears and the line passes into a typical A-4 soil and continues in this type for a little over three miles to the south end of the Rio Grande gorge where the roadway passes into loose and solid rock and talus in which there is so little soil mortar as to be negligible. Soil profiles were not a part of the design at the time plans for this project were drawn but some samples were taken during construction for identification purposes, enough to definitely show the location of controlling soil types.

A curious combination of soil types existed at Sta. 330. A cross section at this station is shown, figure 15. When the contractor opened this cut it appeared to be just another dirt cut. The back slope on the right was staked at 1:1. The cut was excavated and finished before anything happened, and it was a very neat looking job. First indication of trouble was a bulge in the right hand slope at a point about 9 feet above the finished subgrade; at the same time cracks opened farther up the slope, figure 16, and these immediately opened up as the movement gained speed; finally the whole mass moved down and across the finished cut. The cut was cleaned out and the right hand back slope flattened to 2:1. No sooner had the cut been trimmed up than another bulge appeared in the flattened slope.

Cracks developed behind the new slope stakes and again the slope moved down into the roadway. In desperation the engineer moved the top of the slope beyond the most re-

Fig. 10.—Ten thousand pound shot of 40 per cent gelatin dynamite at Sta. 527. Photo credit New Mexico State Tourist Bureau

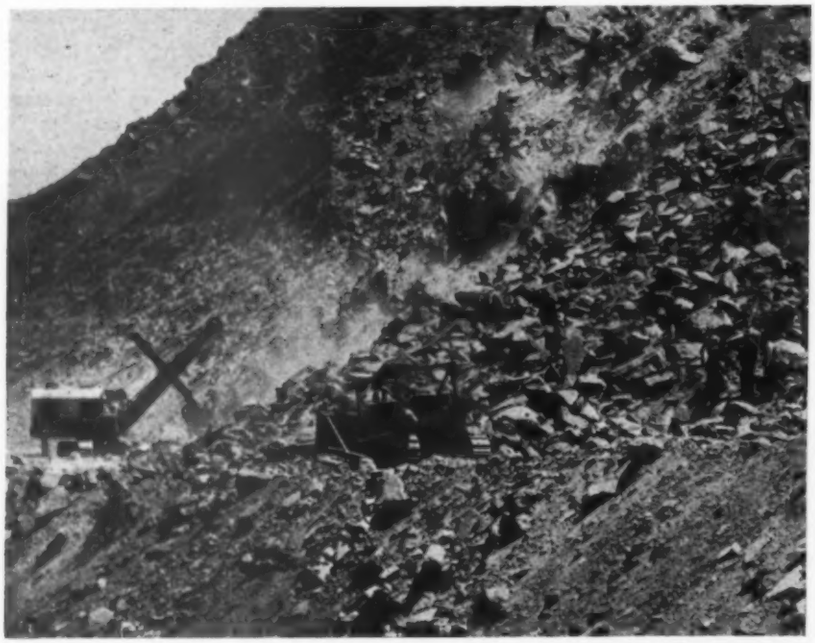


Fig. 11.—Teamwork between the Lima shovel and a Le Tourneau angledozer promptly cleaned up the slide at Sta. 527-530

mote cracks and benched the whole slope, as shown by figure 17. During the time that has elapsed since the last flattening, no movement has taken place. Studies of the material in this hill developed that the soil is predominantly an A-4 and fairly good as this type goes, with a liquid limit of 24 and P.I. of 6.6. Cuts by the hundred have been made in this material elsewhere in this state without developing slides. However, further investigation developed that there was a net work of seams in the mass, ranging in thickness from one-sixteenth inch up to one-quarter inch, most of them about one-eighth inch. Analysis of the material composing the seams disclosed that it was made of particles so finely divided that 100 per cent passed the 200 mesh sieve. It had a liquid limit of 94.3 and P.I. of 52.2. In other words it was a perfect lubricant. There was no definite pattern in the position or distribution of the seams in the soil mass and the tilting which the sediments have undergone since deposition, made it difficult to determine if the seams were the result of alternating periods of soil degradation during the formative periods.

For the benefit of those who might be interested in fitting the Swedish curves to this section, the dry density in pounds per cubic foot of the A-4 soil is 115.

An Innovation in Setting Guard Posts

The New Mexico Highway Department uses the type of guard fence shown in figures 12 and 17, which is not a fence at all but rather a sort of moral suasion.

This rail-less fence is placed on high fills and on this job there were a lot of them, about 900, in fact. These posts are eight inches in diameter and seven feet long. They are set 3½ ft. in the ground.

To set 900 of these, each 3½ ft. down in rock fills was quite a chore. The contractor disposed of this problem very quickly and efficiently with the contraption shown in figure 18. This device consists of a solid, pointed piece of steel at the bottom of a cage. A 2000 pound hammer persuades this implement into the ground. The tool is simple, positive, economical. A royalty for its use was paid to the Gordon Construction Company of Denver, Colorado.

Contractor's Equipment and Personnel

Thygesen's supervisory force consisted of John Alger, General Superintendent; E. M. Silver, in charge of minor grading and structures other than bridges; Carl Jansen supervised the construction of the 4—50 ft. span bridge at Sta. 276+50, figure 20.

Thygesen finished his contract in 161 working days with the equipment listed herewith. His bid price was $317,521.18; the next low bid was $370,032.90; the third low was $392,-453.24. The substantial difference in bids indicates a quite different mental approach on the part of men who have been doing this same kind of work for years. After the letting it developed that one bidder had not worked out in his mind just how he was going to handle 500 cars daily through his job, with the river hemming him in on one side and the cliffs on the other and still move 4,000 yards of muck every day. So he added something to take care of that. Another bidder figured that the rock was a lot harder than Henry thought it was and he added this thought to the thought the first bidder had about the detours and the sum of the two thoughts was so much higher than Henry's thoughts about the same thing that the difference would have made a wonderful profit. They all agreed that Henry had a bear by the tail and was going to have a hard time letting go.

Equipment Used.—Not all of this equipment would be kept on the job

Fig. 12.—Heavy riprap toewall encroached again on the river at Sta. 629

Fig. 13.—Channel change at Sta. 680 completed entirely by bulldozers and angledozers

Fig. 14.—This dumptor went off of a fill where the vertical drop was 40 ft. The skinner jumped and lived. The machine was wrecked, but salvaged

to start with, but it would come on as soon as there was room to work it.

2—12-yd. Le Tourneau scrapers
1—8-yd. Le Tourneau scraper
12—3-cu. yd. Chevrolet dump trucks
3—6-cu. yd. White dump trucks
3—10-S concrete mixers
1—14-S concrete mixer
1—5-S concrete mixer
1—Smith transit concrete mixer—14-cu. ft.
2—105-S Ingersoll-Rand air compressors
1—210-A Ingersoll-Rand air compressor
1—Ingersoll-Rand F.M.2 wagon drill
4—Ingersoll-Rand jack hammers
2—Gardner-Denver jack hammers
1—5 K.W. Le Roi portable light plant
2—Koehler portable light plants
2—Large crawler tractors with bulldozers
1—Large crawler tractor with angledozer
1—Large crawler tractor with angledozer
1—Smaller crawler tractor with bulldozer
1—Small crawler tractor for general utility
1—1½-yd. Northwest diesel shovel
1—2½-yd. Lima diesel shovel
2—⅝-yd. Northwest gas shovels
5—Koehring 6-yd. Dumptors (new)
4—Koehring 6-yd. Dumptors (used)

Second Contract

Almost before the dust had settled on the completed grade, a contract was let for placing a base course and covering this base with our standard two-course penetration wearing surface. Thygesen was low bidder on this also. Specifications called for completion of this work in 60 working days. Thygesen finished in 45 days. On this work he used the following equipment:

1—Cedar Rapids crushing plant 10 by 36 crusher and rolls
12—3-cu. yd. dump trucks
1—500-gallon oil distributor
1—10-ton roller
1—Pneumatic roller
2—No. 12 motor graders
3—Booster tanks
3—1000-gallon water tanks
2—Buckeye chat boxes

Like his grading organization, this outfit was assembled with the end in view of getting the job done in considerably less time than the limit allowed him. You will say that this is what every contractor does. True enough. That's what they think, they do, but the history of construction is full of the obituaries of contracting firms who thought they could do any old job with any old equipment. The writer has seen more than one job go into the red because of inadequate or obsolete equipment when the bid price would have provided a substantial profit had the right kind of equipment been used. The crushing plant set up at Station 522, figure 19, is an example of good equipment properly used. This unit put out 46,000 tons in about 30 days. The raw material is a quartzite gravel of good quality and relatively easy to crush. Of the total tonnage 16,000 tons consisted of crushed material for base course surfacing, No. 2 aggregate, meeting the following grading:

Passing 1½-in.....95-100 per cent
Passing ¾-in..... 40-85 per cent
Passing ¼-in..... 35-70 per cent
Passing No. 200.... 0-15 per cent

Per cent of wear by Los Angeles Rattler Test 65.

30,120 tons of base course surfacing, No. 1 aggregate, were required meeting the following grading:

Passing ¾-in.....95-100 per cent
Passing ¼-in..... 35-75 per cent
Passing No. 200..... 0.15 per cent

Surfacing.—In the surfacing work, the job was divided into two units. The following table gives the stationing and what widths and thicknesses

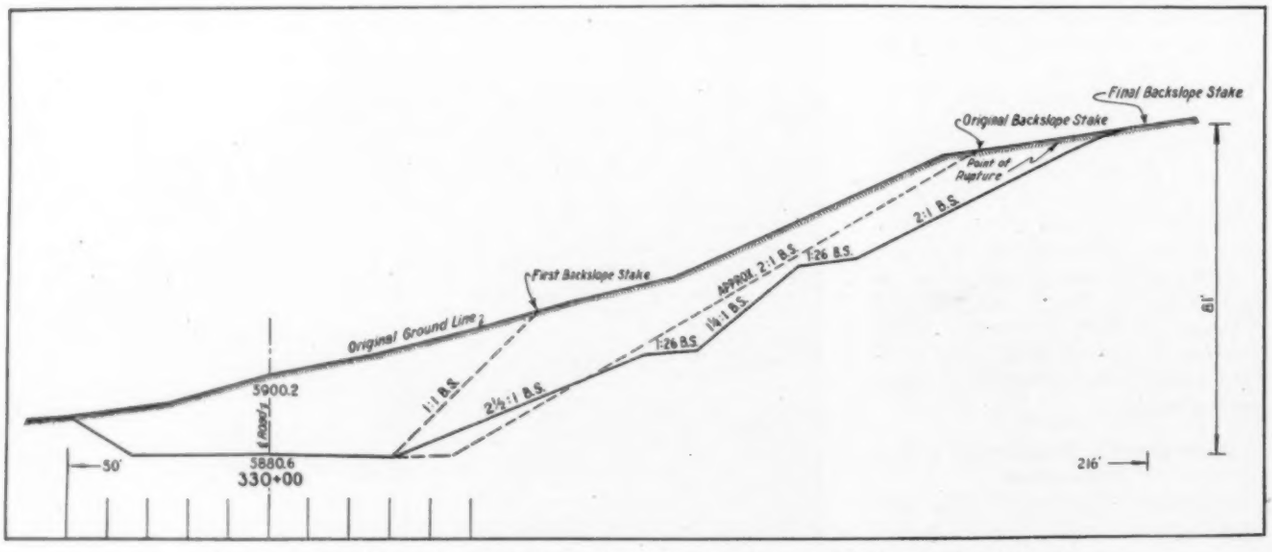


Fig. 15.—Cross section at Sta. 330 where a slide occurred and the backslope had to be flattened

of aggregate, by number, is to be used. Each course was placed in 5 in. layers, watered and rolled to compaction. Four gallons of water per square yard and 20 hours of rolling per mile was required for each course. In the following table where 15 in. of base course was used a 34 ft. wide subgrade was provided. To secure this width the contractor removed approximately 4 in. of the subgrade in place. Excess material was wasted along the shoulders.

3,715 tons of chip stone cover material was used on the final surface course.

State Personnel

The work was done under the supervision of T. G. Brown, Project Engineer for the New Mexico State Highway Department. B. G. Dwyre is State Highway Engineer. John Slye is Senior Highway Engineer for the Public Roads Administration.

After the base course was completed and rolled a prime coat of approximately ½ gallon of MC-1 oil per square yard was applied for a 28 ft. width.

This was followed by New Mexico's standard double penetration oil treated crushed gravel surface placed in two courses. The first course was placed at the rate of one cubic yard to 60 square yards of surface 28 feet in width and treated with asphalt applied at the rate of 0.35 gallons per square yard. The second course was placed at the rate of one cubic yard of aggregate to 120 square yards of surface 22 feet in width and treated with asphalt at the rate of 0.40 gallons per square yard. Cover material

Fig. 16.—View taken of rupture in backslope, at Sta. 330, from a point higher up on the slope looking down toward the finished subgrade, when the slide first started

Station	to	Station	Aggregate No.	Top	Base	Tons Per Sta.	Total Depth
			UNIT No. 1				
274+70[3]	"	319+00	1	28′	30′	67.1	10″ Loose
			2	30′	32′	71.8	
319+00	"	345+00	1	28′	30′	67.1	15″ Loose
			2	30′	32′	71.8	
			2	32′	34′	76.4	
345+00	"	470+00	1	28′	30′	67.1	10″ Loose
			2	30′	32′	71.8	
470+00	"	474+86[1]	1	28′	30′ to 32′	67.1 to 69.4	10″ Loose
			2	30′ to 32′	32′	71.8 to 0	to 5″ Loose
			UNIT No. 2				
474+86[1]	"	705+69[21]		28′	32′	69.4	5″ Loose

Fig. 17.—Cut in right foreground shows final benching resulting from two slides at this point, Sta. 330

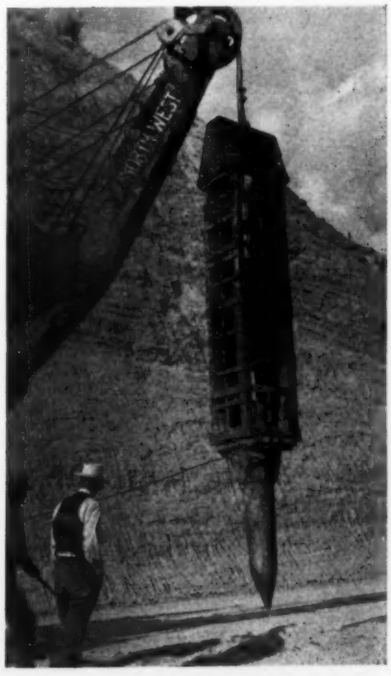


Fig. 18.—Post hole bull punch with 2000 lb. hammer for driving holes for creosoted guard posts

was spread immediately behind the last shot of asphalt with a regulation of not to exceed 15 minutes of elapsed time between asphalt distribution and the spreading of cover material.

Eight hours of tandem rolling per mile was required on each course followed by 12 hours of rolling with pneumatic tired roller for compaction.

All turnouts were surfaced with No. 1 aggregate to the right-of-way line.

To the left is a summary of surfacing quantities.

Estimated Quantities	Unit	Item
313	Hour	Rolling (tandem roller)
30120	Ton	Base course surfacing—No. 1 aggregate
16022	Ton	Base course surfacing—No. 2 aggregate
834	M. Gal	Watering
1588	Bbl.	Liquid asphaltic road oil (type MC-1)
3715	Ton	Cover material
2109	Bbl.	Asphalt
99	Hour	Rolling (pneumatic tired roller)

Fig. 19.—Cedar Rapids 10 in. by 36 in. crusher and rolls portable crushing plant set up opposite Sta. 522 for producing required aggregates. Photo credit New Mexico State Tourist Bureau

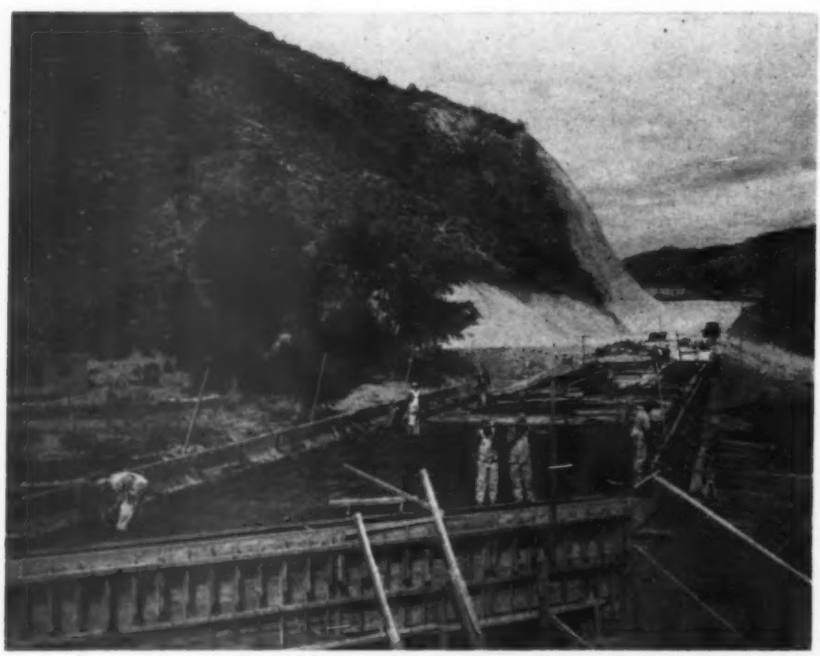


Fig. 20.—Major construction of New Mexico's Kit Carson highway, U. S. 64, between Santa Fe and Taos in the Rio Grande canyon over Embudo Creek, is this 4- 50 ft. concrete span. Placing deck steel. Photo credit New Mexico State Tourist Bureau

Road Facilities for Farms in Middle West

Data from the Minnesota Highway Planning Survey and reports from other states show the percentage of farm dwellings on various types of roads in certain middle western states.

	Percentage on Each Type of Road			
State	Paved	Other Dust-less	Non-Dust-less	Total Sur-faced
Minnesota	3.0	5.8	57.2	66.0
Illinois	16.7	2.1	49.7	68.5
Iowa	5.7	0.6	39.5	45.8
Michigan	9.9	8.9	61.0	79.8
Nebraska	2.0	0.8	25.1	27.9
North Dakota	0.1	0.8	23.3	24.2
South Dakota	0.6	1.8	30.4	32.8
Wisconsin	10.7	10.0	62.6	83.3

Farm units and all other dwellings outside municipal limits are included. The Classification is by type of road reached by main farm or home entrance, although a higher type road may be nearby. In Minnesota, while 66 per cent of rural dwellings are located directly on surfaced roads, 92.2 per cent are within a mile of such a road, 98.3 per cent are within two miles and 99.8 per cent within four miles.

In Minnesota 94.1 per cent of all rural dwellings are located on some type of improved road, surfaced or unsurfaced, 99.2 per cent are within one mile and 99.9 per cent within two miles of an improved road. While Minnesota has 13,787 rural dwellings located on its 11,590 miles of unimproved or primitive roads, only 1,560 of them are more than one mile and only 297 more than two miles from an improved road.

All rural roads are included in the analysis. Only 10.3 per cent of Minnesota rural dwellings are located on trunk highways, but 27.4 per cent are within one mile of a state route, 47.3 per cent within two miles, 62.9 per cent within three miles, 74.9 per cent within four miles and 83.7 per cent within five miles.

"Paved" roads include concrete, brick and high type bituminous, "other dustless" are low type bituminous, and "non-dustless" are gravel or soil-surfaced.

Salvaging Discarded Equipment

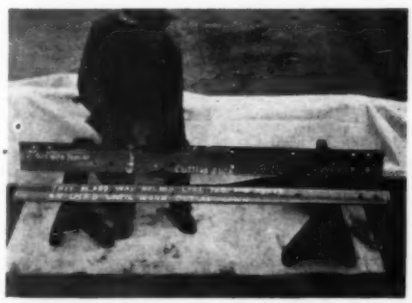
By B. W. DAVIS
State Maintenance Engineer of North Carolina

THE shortage of materials and equipment now makes substitutes essential. The engineer is always confronted with the problem of making one dollar do the work of two.

Now he has the added problem of finding the acceptable substitute for the materials and equipment that is not available. It is necessary to resort to substitutes and salvaging processes that probably would not have been economical twelve or even six months ago.

Rebuilding Grader Blades

Blades for road machines (pull-type graders and motor graders) are not readily available. Even when they are available on a priority basis it is our duty to resort to all practical means to conserve metal for defense uses. The drawing and pictures show how worn grader blades can be lap welded together for further use. This idea was original



Rebuilt grader blade

with the North Carolina Highway District Engineer P. D. Miller.

A welder using a 300 ampere welding unit has in ½ hour and with 2 lbs. of 3/16-in. "Manganal Welding Electrodes" spot welded two 72 in. x 6 in. x ½ in. worn blades into one rebuilt blade.

Our experience with the use of rebuilt blades has been limited. However, the reclaimed blades apparently are doing a satisfactory job on ordinary maintenance work.

Guard trailer attached to truck

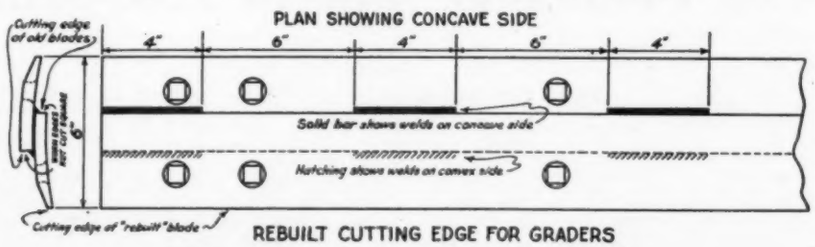
Home Made Trailer

The North Carolina State Highway and Public Works Commission has approximately 9,000 prisoners for use in maintaining approximately 60,000 miles of state and county roads. A large percentage of these prisoners must be transported to the localities where they are to be worked. They must be guarded while in transit. The picture shows a trailer attached to a truck loaded with prisoners and a close view of the trailer provided for the guard. The cab on this trailer is salvaged from a discarded 1½-ton truck. This unit provides an excellent closed cab for the guard and eliminates the expense of building a "home-made" cab that would be less substantial and less comfortable for the guard.

Rebuilt Mower

In the rebuilt pull-type mowing machine, shown in the pictures, the wheels, axle, housings, and gears of the old discarded farm pull-type farm mower have been replaced by similar units from a discarded 1½-ton truck. The salvaged truck rear axle housing and transmission housing are connected directly. The use of the transmission gives the cutter bar several speeds.

The rebuilding or reconstruction process is borrowed from a similar rebuilt mower observed in a South Carolina Highway Department shop.



REBUILT CUTTING EDGE FOR GRADERS

Sketch showing method of welding worn grader blades

Rebuilt pull-type mower

Members State Highway Department Engineering Personnel Now in U. S. Military Service

NEW HAMPSHIRE

W. Bean, Resident Engineer, Captain, Coast Artillery.
W. Burtt, (Sign Shop), Private, Army.
M. Chase, Chief of Party, 1st Lieutenant, Coast Artillery.
S. G. Costine, Inspector, Private, Camp Devens.
N. Cricenti, Transitman, 1st Lieutenant, Coast Artillery.
E. Davis, Jr. Resident Engineer, Lieutenant.
J. R. Dinsmoor, Rodman.
R. Donahue, Transitman.
S. E. Dutton, Clerk, Lt. Colonel, Field Artillery.
D. L. Fosburgh, Cost Accountant, 2nd Lieutenant, Coast Artillery.
R. Hall, (Sign Shop), Private.
W. Haynes, Jr. Resident Engineer, Major, Coast Artillery (AA).
J. S. Holden, Chief of Party, Private, M. P. Battalion.
J. H. Huckins, Clerk, Captain, Armored Division.
R. Lovering, Cost Clerk, Private, Camp Devens.
A. Moody, Rodman, Private.
L. B. Morrill, (Planning Survey), Private, Coast Artillery.
C. W. Moses, Rodman.
E. R. Munsen, Draftsman, 1st Lieutenant, Coast Artillery.
S. Otis, Inspector, Captain, Coast Artillery.
S. Page, Chief Draftsman, Captain, Ordinance Dept.
C. Pease, Draftsman, 2nd Lieutenant, Balloon Barrage.
E. Perry, Rodman.
D. Richards, Chief of Party, 1st Lieutenant, Field Artillery.
P. Smith, Rodman.
W. Snow, Rodman, Seaman, Navy.
C. H. Thyng, Draftsman, Lieutenant, Instr. M. I. T. (C. A.).
R. Whitaker, Sr. Resident Engineer, Lieutenant, J. G., Navy.

VERMONT

W. G. Barrett, Design Engineer Bridges, Infantry, Lt. Col.
D. W. Patterson, Bridge Designer, Selective Service Hdq., Major.
H. G. Howard, Resident Engineer, Infantry, Captain.
W. Pratt, Voucher Clerk, Infantry, Captain.
W. Stebbins, Bridge Designer, Infantry, Captain.
P. Thomas, Traffic Supervisor, Signal Corps, Captain.
E. R. White, Jr., Resident Engineer, Armored Force, 1st Lieutenant.
W. Barber, Asst. R. O. W. Dept., Infantry, Lieutenant.
E. R. Ricker, Resident Engineer, Army, Lieutenant.
C. J. Bailey, Engineer Traffic Survey, Cavalry, 2nd Lieutenant.
L. W. Brownell, Resident Engineer, Coast Artillery, 2nd Lieutenant.
N. H. Colby, Resident Engineer, Const. Q. M. Corps, 2nd Lieutenant.
C. F. Laythe, Resident Engineer, Army, 2nd Lieutenant.
C. W. Utley, Resident Engineer, Army, 2nd Lieutenant.
A. L. Williams, Resident Engineer, Q. M. Corps, 2nd Lieutenant.
J. H. Cass, Resident Engineer, Coast Artillery, Sergeant.
E. Peer, Draftsman, Infantry, Sergeant.
H. L. Cowles, Draftsman, Air Corps, Private.
S. R. Dunn, Inspector, Army, Private.
J. Durkee, Resident Engineer, Army, Private.
M. Orcutt, Payroll Clerk, Navy, Enlisted.

RHODE ISLAND

D. J. Bonn, Laborer, Private, Army.
F. J. Chase, Instrument Man, Private, Army.
A. E. Choquette, Laborer, Private, Army.
W. Couture, Laborer, Private, Army.
R. F. Cunningham, Laborer, Private, Army.
S. DiLustro, Senior Materials Plant Inspector, Ensign, Naval Reserve.
A. V. DiMartino, Engineering Survey Aide, Private, Army.
J. W. Healey, Jr., Motor Equipment Operator, Private, Army Air Corps.
E. R. Howard, Motor Equipment Operator, Private, Army.
L. E. Hutchins, Laborer, Private, Army.
W. R. Johnson, Engineering Survey Aide, Private, Army.
W. J. Jordan, Senior Clerk Stenographer, Sergeant, Army.
H. Kelly, Fireman, Chief Machinists Mate, Navy.
L. M. Laporte, Laborer, Private, Army.
F. W. Lepore, Laborer, Private, Army.
F. A. Lynch, Engineering Office Aide, Sergeant, Army.
L. B. Merrett, Laborer, Private, Army.
J. J. Palazio, Motor Equipment Operator, Private, Army.
E. F. Preziuso, Bridge Worker, Appr. Seaman, Naval Reserve.
J. H. Richardson, Construction Inspector, 1st Lieutenant, Army.
J. Santillo, Laborer, Private, Army.
M. F. Swanson, Motor Equipment Operator, Private, Army Air Corps.
C. A. Sweet, Jr., Motor Equipment Operator, Private, Marine Corps.
E. T. Sexton, Truck Driver, Private, Army.
A. J. Towers, Motor Equipment Operator, Private, Army.

NEW YORK

R. O. Alquist, Sr. Engineering Aide, Captain, Field Artillery, Army.
*P. Backston, Jr. Civil Engineer, Private, Army.
*W. C. Benedict, Jr. C. E. (B. & G. S.), Private, Army.
R. W. Benjamin, Sr. Engineering Aide, Sergeant, Field Artillery, Army.
J. L. Bennett, Engineering Helper, Carpenter's Mate (1st class), Navy.
C. E. Billion, Jr. C. E. (Hys.), Major, 1st Area Hdqrs., Army.
F. J. Bonini, Sr. Engineering Aide, Captain, Army.
W. Bouck, Engineering Helper, Private, Army.
C. Broadbent, Jr. Engng. Aide, Lt. Pers. Officer, Navy Const. Train. Center.
J. R. Carmody, Engineering Helper, Private, Air Corps, Army.
W. H. Carter, Sr. Engineering Aide, Carpenter's Mate (1st class), Navy.
A. D. Comrie, Sr. Engineering Aide, Chief Carpenter's Mate, Navy.
J. K. Coughlan. Sr. Engineering Aide, Captain, Air Corps, Army.
R. Dixon, Engineering Helper, Private, Army.
W. A. Domedion, Engineering Helper, Private, Army.
*B. C. Eighmie, Jr. C. E. (Hys.), Chief Carpenter's Mate, Navy.
F. Eylers, Sr. Engineering Aide, Private, Army.
T. F. Farrell, Chief Engineer of Dept., Colonel, Army.
A. W. Fleming, Sr. Engineering Aide, Private, Army.
E. W. Fleming, Jr. Draftsman, Machinist's Mate, Navy.
G. W. Flynn, Asst. Supt. of Constr., Lieutenant, Navy.
C. B. Freday, Jr. C. E. (B. & G. S.), Lieutenant, C. E. Corps, Navy.
J. T. Glynn, Engineering Helper, Seaman, (1st class), Navy.
B. F. X. Golden, Engineering Helper, Private, Army.
G. W. Griffin, Engineering Helper, Private, Army.
C. E. Haggerty, Sr. Draftsman, Private, Army.
H. H. Harmon, Sr. Engineering Aide, Major, Army.
J. F. Hoffman, Jr. C. E. (Gen.), 2nd Lieutenant, Air Corps, Army.
G. P. Irvine, Engineering Helper, Private, Army.
C. J. Isley, Sr. Engineering Aide, 1st Lieutenant, Engr. Corps, Army.
J. L. Johnson, Engineering Helper, Private, Army.
A. R. Ketchum, Sr. Engineering Aide, 1st. Lieutenant, Engr. Corps, Army.
R. P. Keyes, Sr. Engineering Aide, Chief Carpenter's Mate, Navy.
J. P. Larsen, Assoc. C. E. (Hys.), Captain, U. S. Engr.'s Off., Army
E. T. Lynch, Jr. C. E. (B. & G. S.), Private, Army.
J. D. Manning, Jr. C. E. (B. & G. S.), 1st Lieut., Field Artillery, Army.
C. W. Markland, Sr. Engineering Aide, 1st Lieutenant, Infantry, Army.
F. E. Masse, Engineering Helper, Corp., Coast Artillery, Army.
I. D. McClellan, Sr. Engineering Aide, Chief Carpenter's Mate, Navy.
E. F. McDonald, Jr. C. E. (Hys.), Chief Carpenter's Mate, Navy.
I. C. McIlwaine, Jr. C. E. (B. & G. S.), Lieutenant, Navy.
H. McKenna, Jr. Engineering Aide, Chief Carpenter's Mate, Navy.
W. S. Morrison, Sr. Engineering Aide, Private, Army.
F. K. Nelson, Sr. Draftsman, Private, Army.
J. F. Payne, Jr. C. E. (Hys.), Private, Army.
E. R. Peters, Jr., Jr. C. E. (B. & G. S.), Lieutenant, C. E. Corps, Navy.
H. J. Petrie, Jr. C. E. (B. & G. S.), Private, Army.
F. J. Reid, Jr. C. E. (B. & G. S.), Chief Machinist's Mate, Navy.
H. E. Reid, Sr. Engineering Aide, Lieutenant, C. E. Corps, Navy.
H. J. Rooney, Jr. C. E. (Hys.), Chief Carpenter's Mate, Navy.
F. Ruggeri, Engineering Helper, Private, Army.
H. Scott, Sr. Engineering Aide, Chief Carpenter's Mate, Navy.
J. R. Simpson, Engineering Helper, Private, Army.
R. D. Simpson, Engineering Helper, Private, Army.
J. B. Staley, Sr. Bldg. Constr. Engr., Lieutenant Commander, Navy.
R. W. Sweet, Asst. C. E. (Hys.), Chief Carpenter's Mate, Navy.
J. Taylor, Engineering Helper, Private, Army.
J. J. Walsh, Sr. Engineering Aide, Private, Army.
J. J. Wick, Engineering Helper, Private, Army.
J. W. Wiley, Sr. Engineering Aide, Private, Army.
B. Williams, Jr. Draftsman, Ensign, Navy.

NEW JERSEY

L. E. Angster, Private, Army, Jr. Highway Inspector.
E. E. Ayers, Private, Army, Jr. Highway Inspector.
J. Baragona, Sergeant, Army, Rodman.
J. Barrett, Private, Army, Jr. Highway Inspector.
H. A. Blake, Private, Army, Draftsman.
E. L. Boldt, Private, Army, Jr. Highway Inspector.
R. H. Callahan, Private, Army, Asst. Civil Engineer.
G. Collins, Private, Army, Jr. Civil Engineer.
A. Cook, Private, Army, Chainman.
C. Cook, Private, Army, Chainman.
R. Crawford, Lieutenant, Army, Asst. Civil Engineer.
A. W. Crea, Lieutenant, Army, Highway Inspector.
C. V. Dickinson, Lieut.-Colonel, Army, Foreman, Hwy. Maint.
R. G. Dougherty, Lieutenant, Army, Chainman.
A. A. Faxon, Lieutenant, Army, Asst. Civil Engineer.
H. T. Fisher, Captain, Army, Sr. Civil Engineer.
J. R. Flynn, Private, Army, Jr. Civil Engineer.
E. L. Forrest, Aviation Cadet, Air Corps, Jr. Civil Engineer.
G. F. Forster, Lieut.-Commander, Navy, Supv. of Traffic.
F. Foster, Captain, Army, Jr. Civil Engineer.
M. Giordano, Sergeant, Army, Chainman.
R. B. Haight, Private, Army, Jr. Civil Engineer.
A. B. Holland, Private, Army, Draftsman.
C. Kenyon, Captain, Army, Highway Inspector.
J. Maiorino, Private, Army, Draftsman.
J. F. McGarry, Lieutenant, Army, Highway Inspector.
H. J. Meury, Lieutenant, Army, Maint. Inspec. Hwy.
R. C. Newman, Aviation Cadet, Air Corps, Draftsman.
A. L. Oelkers, Private, Army, Sr. Draftsman.
G. S. Packer, Private, Army, Asst. Civil Engineer.
G. W. Patton, Private, Army, Jr. Civil Engineer.
M. Seibert, Private, Army, Chainman.
R. A. Simpson, Lieutenant, Army, Jr. Civil Engineer.
F. V. Speth, Private, Army, Jr. Highway Inspector.
C. M. Stenson, Private, Army, Rodman.
W. Tallon, Sergeant, Army, Chainman.
I. W. Thomas, Private, Army, Rodman.
E. C. Walsh, Jr., Lieutenant, Army, Jr. Highway Inspector.
R. R. Wilcox, Private, Army, Jr. Civil Engineer.

VIRGINIA

J. H. J. Adams, Sr. Highway Draftsman, 1st Lieut., U. S. Engrs.
R. N. Adamson, Jr. Engineering Aide, Naval Reserve.
O. T. Aichel, Resident Engineer, 60th Inf.
E. O. Allen, Sr. Engineering Draftsman, L. M. C., Naval Opr.
T. L. Anderson, Pr. Engineering Aide.
M. C. Bane, Jr., Pr. Engineering Aide, Lieutenant, Maxwell Field.
C. C. Battige, Sr. Bridge Design Engineer, Captain, Infantry.
N. E. Birch, Jr. Highway Engineer, Army.
J. S. Board, Jr. Highway Engineer, 1st Lieutenant, Infantry.
W. O. Breedlove, Pr. Engineering Aide, Field Artillery.
B. Brodie, Jr. Engineering Aide, Sergeant, Q. M. Depot.
T. N. Broaddus, Sr. Engineering Draftsman, Naval Reserve.
J. C. Bullock, Jr., Sr. Engineering Aide, Army.
R. L. Burke, Jr., Jr. Engineering Aide, Army.
W. E. Bussells, Sr. Engineering Aide, Cadet, Air Corps.
H. D. Carper, Pr. Engineering Aide, Navy.
R. C. Christian, Pr. Engineering Aide, Army.
L. M. Clemmer, Sr. Engineering Aide, Army.
P. B. Coldiron, Pr. Engineering Aide, 2nd Lieutenant, Cavalry.
M. W. Cole, Jr. Engineering Aide, Army.
S. J. Damiani, Sr. Engineering Aide, Army.
A. T. Davis, Jr., Pr. Matl. Engr. Aide, Marine Corps.
F. W. Danner, III, Sr. Engineering Aide, Air Corps.
E. L. Delaney, Jr., Sr. Engineering Aide, Army.
M. B. Dickinson, Jr. Engineering Aide, Army.
W. H. Dorin, Jr., Jr. Highway Draftsman-Engineer, Captain, Army.
T. H. Duffy, Jr., Sr. Engineering Draftsman, Sergeant, Infantry.
H. E. DuVal, Sr. Engineering Draftsman, 2nd Lieutenant, Army.
C. Early, Pr. Engineering Aide, Army.
R. A. Edwards, Sr. Engineering Draftsman, 2nd Lieutenant, Army.
R. B. Edwards, Jr., Pr. Engineering Aide, 2nd Lieutenant, Army.
C. R. Elam, Jr., Pr. Engineering Draftsman, 1st Lieutenant, Army.
H. M. Elliott, Jr. Engineering Aide.
A. W. Ellis, Pr.Matls. Engr. Aide, 2nd Lieutenant, Army.
W. M. Ewing, Sr. Engineering Aide, 1st Lieutenant, Air Corps.
A. A. Fahrner, Sr. Engineering Draftsman, Ensign, Navy.
A. J. Farley, Jr. Highway Engineer, Army.
C. P. Fisher, Jr., Jr. Engineering Aide, 2nd Cl. Seaman.
J. W. Flewellen, Sr. Engineering Aide, Air Corps.
R. C. Forbes, Sr. Engineering Draftsman, Air Corps.
A. McK. Fox,Pr. Engineering Aide, Coast Artillery.
D. B. Fugate, Resident Engineer, 1st Lieutenant, Air Corps.
R. P. Fulton, Jr. Highway Engineer, 2nd Lieutenant, Engineers Reserve.
E. W. Fulcher, Jr. Engineering Aide, Army.
L. H. Garland, Jr., Jr. Materials Engineer, Army.
C. A. Gathright, Sr. Engineering Aide, Marine Corps.
J. R. Gibson, Jr. Engineering Aide, Army.
J. B. Godwin, Sr. Engineering Draftsman, Infantry.
J. T. Gwaltney, Sr. Engineering Aide.
J. K. Haley, Jr., Pr. Matls. Engineer, 2nd Lieutenant, Field Artillery.
H. F. Hamilton, Sr. Engineering Aide, Cadet, Air Corps.
O. M. Haney, Jr. Highway Engineer, 1st Lieutenant, Army.
H. H. Haney, Sr. Engineering Draftsman, Air Corps.
G. D. Hann, Jr., Sr. Highway Draftsman, 2nd Lieutenant, Coast Artillery.
J. N. Harris, Sr. Highway Engineer, 2nd Lieutenant, Corps of Engineers.
E. M. Howell, Jr. Engineering Aide.
J. E. Howell, Pr. Engineering Aide, Private, Surveys.
E. F. Hunsberger, Pr. Engineering Aide, Air Corps.
P. A. Jackson, Sr. Engineering Draftsman, Naval Air Corps.
H. A. Jacob, Jr., Jr. Analytical Chemist, 2nd Lieutenant, Infantry.
G. R. Kauffman, Pr. Engineering Aide, 2nd Lieutenant, Infantry.
J. J. Kelly, Sr. Engineering Draftsman, 2nd Lieutenant, Army.
R. W. Kilmartin, Sr. Engineering Aide, Cadet, Army Aviation Corps.
H. B. Kucheman, Sr. Engineering Draftsman, Army Air Corps.
A. G. Lambert, Pr. Engineering Draftsman, Cadet, Air Corps.
S. J. Lanier, Jr. Engineering Aide, Private, Air Corps.
E. K. Long, Sr. Engineering Draftsman, U. S. Engineers.
C. K. Luck, Sr. Engineering Draftsman, 1st Lieutenant, Engineers.
G. B. Luck, Pr. Engineering Draftsman, 1st Lieutenant, Infantry.
G. A. Lyell, Pr. Engineering Aide, Air Corps.
A. B. Lynch, Pr. Engineering Aide, 2nd Lieutenant, Coast Artillery.
R. B. Lyon, Sr. Engineering Draftsman, Naval Reserve Aviation.
F. W. McSwain, Jr. Engineering Aide, Naval Reserve.
H. C. McGrath, Jr. Engineering Aide, 2nd Lieutenant, Engr. Reserves.
G. D. Mandaleris, Sr. Engineering Draftsman, Naval Reserve.
E. S. Marchant, Pr. Engineering Aide, Navy.
L. M. Mayo, Pr. Engineering Aide, Signal Corps.
I. D. Micks, Jr. Engineering Aide, Army.
R. J. Miller, Sr. Engineering Aide, Army.
R. O. Miller, Sr. Engineering Draftsman, 2nd Lieutenant, Army.
O. N. Millery, Jr., Pr. Engineering Draftsman, Officers Training School.
S. C. Moore, Jr., Sr. Engineering Draftsman, Corporal, Infantry.
J. C. Mountcastle, Jr. Engineering Aide, Midshipman, Navy.
T. W. Nance, Pr. Highway Engineer, 3rd Cl. Storekeeper, Navy.
P. E. Nauman, Sr. Engineering Draftsman, 2nd Lieutenant, Army.
R. C. Nelson, Pr. Engineering Aide.
D. L. Newman, Jr. Engineering Aide, Aviation Corps.
D. A. Preston, Pr. Engineering Aide, Navy.
J. R. Preston, Sr. Highway Engineer, Field Artillery.
V. R. Pugh, Jr. Materials Engineer, 2nd Lieutenant, Engineer Corps.
M. A. Ramsey, Pr. Engineering Aide.
M. C. Revercomb, Sr. Engineering Draftsman, Navy.
L. W. Roye, Sr. Engineering Draftsman, Coast Artillery.
D. P. Sanders, Jr. Engineering Aide, Private, Engineer Corps.
G. Scott, Jr. Engineering Aide, Army.
E. A. Sexton, Jr. Engineering Aide, Naval Aviation.
A. T. Shepherd, Sr. Engineering Draftsman, Navy.
R. W. Shiflett, Pr. Engineering Aide, Officer, Naval Reserve.
C. J. Siegrist, Jr., Pr. Engineering Aide, 1st Lieutenant, Coast Artillery.
E. H. Smith, Jr. Engineering Aide, Petty Officer, Naval Reserve.
J. S. Sowers, Sr. Engineering Aide, Army.
J. W. Smith, Pr. Engineering Aide, Army.
G. R. Spiers, Jr. Engineering Aide, Bombardment Group.
H. Stockdell, Sr. Engineering Draftsman, Private, Infantry.
G. W. Stone, Pr. Engineering Draftsman, 1st Lieutenant, Army.
R. L. Strange, Jr. Engineering Aide, Aviation Cadet.
D. A. Stover, Jr., Pr. Engineering Aide, Engineer Reserves.
L. M. Tereschenko, Sr. Engineering Aide, Field Artillery.
J. D. Thornton, Jr. Engineering Aide, Army.
F. T. Tolson, Sr. Engineering Draftsman, 2nd Lieutenant, Infantry.
H. P. Townsley, Pr. Engineering Aide, Sergeant, Infantry.
R. M. VonRichter, Jr. Highway Engineer, Lieutenant, Air Service.
H. L. Wauldbauer, Jr., Pr. Engineering Aide, Infantry.
R. R. Weisiger, Jr. Engineering Aide.
T. C. Whitworth, Jr., Pr. Hwy Engrng.-Draftsman, 2nd Lieut., Coast Art.
E. B. Williams, Jr. Engineering Aide, Army.
R. K. Williams, Jr., Pr. Mtls. Engrng Aide, 2nd Lieut., Coast Artillery.
A. G. Wiltshire, Sr. Engineering Aide, Air Corps.

* Title, according to last information.

SOUTH CAROLINA

J. R. Ambrose, Inspector (Bridge), Army.
H. Cantey, Jr., Resident Engineer, Navy.
B. H. Cauthen, Mechanic, Navy.
F. C. Chitty, Jr., Inspector (Bridge), Army.
J. D. Clark, Clerk, Army.
J. A. Cole, Foreman, Army.
T. O. Curlee, Jr., Material Inspector, Army.
J. W. Davis, Construction Superintendent, Army.
D. A. Dillard, Draftsman, Army.
A. D. Dukes, Designer, Army Air Corps.
W. W. Evett, Inspector, Army Ordnance.
J. G. Farmer, Engineer Asst., Army Air Corps.
W. C. Fore, Draftsman, Army.
L. A. Gambill, Material Inspector, Army.
L. B. Garrison, Inspector, Army.
C. P. Hamrick, Recorder, Army.
C. Harrelson, Bridge Operator, Navy.
J. S. Heiss, Resident Engineer, Army.
J. H. Hennecy, Clerk, Army.
E. Herrin, Clerk, Army.
C. L. Hightower, Draftsman, Army.
F. F. Hill, Jr., Office Assistant, Navy.
J. T. Hiller, Office Assistant, Army.
O. Holland, Inspector, Navy.
J. O. Holladay, Foreman, Army.
H. Jackson, Clerk, Army.
P. M. Jeffords, Resident Engineer, Navy.
L. M. Justice, Inspector, Army Air Corps.
W. O. Kaminer, Jr., Instrumentman, Army.
J. A. Kinghorn, Jr., Asst. Resident Engineer, Navy.
J. E. Lemond, Inspector, Army.
J. J. Mackay, Jr., Chief of Party, Army.
S. J. Mathis, Engineer Assistant, Navy.
H. M. Mims, Resident Engineer, Navy.
R. W. Moorman, Draftsman, Navy.
M. L. Murph, Jr., Instrumentman, Army.
W. S. Murph, Resident Engineer, Army.
D. D. Page, Instrumentman, Army.
J. Peele, Jr., Inspector, Marines.
L. A. Perry, Designer, Army Air Corps.
J. W. Player, Material Inspector, Army.
A. H. Pregnall, Jr., Inspector, Army.
P. Psillos, Inspector, Army.
S. H. Rodgers, Asst. Resident Engineer, Navy.
J. D. Riel, Draftsman, Army.
G. A. Sease, Inspector, Army.
J. W. Simmons, Inspector, Army Air Corps.
M. L. Smith, Resident Engineer, Army.
W. P. Sullivan, Clerk, Army.
A. D. Sutton, Inspector, Army.
T. Therrell, Instrumentman, Army.
G. R. Webb, Jr., Inspector, Army.
J. L. White, Instrumentman, Army.
W. L. White, Mechanic, Navy.
J. M. Wilburn, Instrumentman, Army.
G. Williams, Instrumentman, Army.
L. D. Wilson, Jr., Clerk, Navy.
T. E. Wilson, Jr., Resident Engineer, Army.
A. G. Yarbrough, Material Inspector, Army.
B. Allsbrook, Rodman, Army.
W. F. Appleby, Rodman, Army.
F. S. Bland, Rodman, Army.
J. A. Busbee, Rodman, Army.
B. A. Cothran, Rodman, Army Air Corps.
E. B. Dunbar, Rodman, Army.
C. W. Gomperts, Jr., Rodman, Army.
J. O. Graham, Rodman, Army.
W. C. Grant, Rodman, Army Air Corps.
H. V. Harbort, Rodman, Navy.
H. F. Harmon, Rodman, Army.
J. F. Hollingsworth, Jr., Rodman, Army.
J. E. Horton, Rodman, Army.
W. H. Horton, Rodman, Army.
J. E. Lawson, Rodman, Army.
J. L. McDaniel, Rodman, Army.
E. Odom, Rodman, Army.
E. H. Pinckney, Jr., Rodman, Army.
J. E. Player, Rodman, Army.
W. Scoggins, Rodman, Navy.
G. Still, Rodman, Army.
K. Stuckey, Rodman, Army.

ALABAMA

A. G. Abernathy, Drawbridge Tendr., Private, Army.
C. L. Adams, Sr. C. Engr., 1st Lieutenant, Field Artillery.
C. D. Adams, C. Engr. Aide, Private, Army.
C. W. Anderson, Sr. C. Engr. Aide, 1st Lieutenant, Field Artillery.
F. K. Bagby,Sr. Engr. Aide, 2nd Lieutenant, Officers Reserve Corps.
E. K. Barnes, Sr. C. Engr. Aide, 1st Sergeant, Infantry.
W. R. Bean, C. Engr. Aide Coop., Private, Infantry.
W. H. Blakeney, Sr. C. Engr. Aide, Private, Army.
R. C. Blalock, C. Engr. Aide, Private, Medical Detachment.
R. P. Boyd, Jr., Jr. C. Engr., 1st Lieutenant, Engr. Corps, Army.
W. R. Brassell, Radio Serviceman, Private, Army.
J. E. Bridges, Sr. Mo. Eqp. Opr., Private, Army.
J. Brown, Jr. C. Engr., 2nd Lieutenant, Engr. Corps, Army.
J. K. Brown, Sr. Engr. Aide, Private, Army.
T. A. Brown, Jr. C. Engr., Navy.
V. Brown, C. Engr. Aide, Army.
H. L. Burson, Jr., C. Engr. Aide, Air Corps.
R. W. Butts, C. Engr. Aide, Private, Army.
W. T. Brown, C. Engr. Aide, Private, Army.
R. W. Carpenter, Sr. C. Engr. Aide, Private, Observation Squadron.
C. W. Carr, C. Engr. Aide, 1st Lieutenant, Engr. Reserve.
W. C. Carter, C. Engr. Aide, Private, Army.
S. G. Cato, Statistical Aide, Private, Army.
E. E. Caudill, Sr. C. Engr. Aide, Private, Army.
S. E. Caudill, Jr., Jr. Engr., Private, Army.
J. T. Cheriones, Tab. Mach. Oper., 2nd Lieutenant, Army.
W. J. Chestnut, Sr. C. Engr. Aide, Ensign, Navy.
J. F. Clements, Sr. Auto Mech., Avia., Navy.
C. J. Cleveland, C. Engr. Aide, Navy.
W. E. Colvard, C. Engr. Aide, Private, Air Corps.
W. M. Corder, Sr. C. Engr. Aide, Private, Army.
E. G. Corkren, C. Engr. Aide, Private, Field Artillery.
R. M. Corley, C. Engr. Aide, Private, Army.
J. D. Cotton, C. Engr. Aide, Private, Marines.
D. H. Cowan, Sr. Mo. Eqp. Opr., Private, Coast Artillery.
J. Crook, C. Engr. Aide, Private, Field Artillery.
W. R. Crook, Sr. Engr. Aide, 1st Lieutenant, Air Corps.
H. G. Dailey, Jr., Sr. C. E. Aide Coop., Air Corps.
R. W. Dees, Jr. C. Engr., 2nd Lieutenant, Engr. Corps.
Wm. P. DeJarnette, Jr., Prin. C. Engr., Captain, Army.
M. DeShazo, Sr. C. Engr. Aide, Ordnance Department, Army.
A. J. Dickenson, C. Engr. Aide, Private, Army.
M. Diefenderfer, Sr. C. Engr. Aide, Private, Army.
C. I. Dreyfus, C. Engr. Aide, Air Corps.
J. Duke, Sr. C. Engr. Aide, Petty Officer, Navy.
J. A. Duke, Sr. C. Engr. Aide, Private, Army.
O. M. Dukes, Sr. C. Engr. Aide.
J. P. Dumas, C. Engr. Aide, Private, Army.
R. Dumas, Sr. C. Engr. Aide, Private, Army.
J. B. Dunbar, Sr. C. Engr., 1st Lieutenant, Field Artillery, Army.
W. A. Dundon, Sr. Engr. Aide, Private, Army.
T. H. Eastep, C. Engr. Aide, Line Sergeant, National Guard.
A. Q. Edmonson, Sr. Engr. Aide, 1st Lieutenant, Field Artillery.
V. C. Elgin, Jr., Sr. C. Engr. Aide, Private.
T. J. Elliott, C. Engr. Aide, Private, Army.
B. W. Embry, C. Engr. Aide, 2nd Lieutenant, Engineers.
D. R. Espy, Auto Mechanic, Private, National Guards.
J. E. Etheridge, C. Engr. Aide, Private, Army.
R. N. Farish, Jr. C. Engr., Private, Army.
A. H. Feagin, Asst. C. Engr.
E. O. Folmar, Sr. C Engr. Aide, Appr. Seaman, Navy.
W. E. Folmar,Sr. Engr. Aide, Air Corps.
W. T. French, C. Engr. Aide, Private, Army Air Corps.
M. H. Frost, Sr. C. Engr. Aide, Private, Army.
H. L. Fuller, Asst. C. Engr., 1st Lieutenant, O. R. C., Army.
F. B. Garrett, Asso. C. Engr., 1st Lieutenant, Engr. Reserve.
J. D. Giles, C. Engr. Aide, Private, Army.
H. Goggins, Carpenter, Seaman, Navy.
A. T. Goodwyn, Sr. C. Engr., 1st Lieutenant, U. S. Engineers.
J. M. Grant, Sr. Auto Mechanic, Private, Army.
W. L. Grant, C. Engr. Aide, Private, Army.
A. Griffin, Sr. Engr. Aide, Private, Army.
T. J. Guerin, C. Engr. Aide, Private, Field Artillery.
J. C. Hall, C. Engr. Aide, Private, Marine Corps.
J. W. Ham, C. Engr. Aide, Private, National Guard.
I. T. Harbin, Sr. C. Engr. Aide, Petty Officer, Navy.
R. H. Harris, C. Engr. Aide, Flying Cadet, Air Corps.
T. J. Harrison, Jr., Sr. Engr. Aide, Private, Army.
J. B. Harvey, Whse. Shop Supt., Captain, Quartermaster Reserve.
C. I. Hawkins, C. Engr. Aide, Private, National Guard.
M. F. Hayles, Sr. Engr. Aide, Private, Army.
E. F. Helms,Typist, Private, Army.
J. C. Henderson, C. Engr. Aide, Private, Army.
E. I. Henson, Sr. C. Engr., 1st Lieutenant, Engr. Corps.
J. A. Hester, Asst. C. Engr., 1st Lieutenant, Field Artillery.
W. D. Holcomb, C. Engr. Aide, Navy.
W. B. Hollinger, C. Engr. Aide, Private, Army.
R. M. Honeycutt, Sr. C. Engr. Aide, Private, Marine Corps.
H. A. Hooker, Prin. Mo. Eqp. Opr., Private, Army.
W. F. Hughes, Sr. C. Engr. Aide, National Guard.
F. H. Ingram, Asso. C. Engr., Captain, Field Artillery.
W. H. Jenkins, Jr. C. Engr., Private, Army.
J. L. Jernigan, Sr. C. Engr. Aide, 2nd Lieutenant, Tank Battalion, Army.
D. Johnson, C. Engr. Aide, Private, Army.
F. W. Johnson, C. Engr. Aide, Private, Army.
H. B. Johnson, C. Engr. Aide, Plc. F. A., Army.
J. P. Jones, C. Engr. Aide, Private, National Guard.
J. R. Jones, C. Engr. Aide, Army.
J. H. Jones, Sr. C. Engr. Aide, Army Air Corps.
T. S. Jones, Statis Aide, Flying Cadet, Air Corps.
H. W. Jordan, Sr. C. Engr. Aide, Private, Army.
D. Kelly, Sr. Hwy. Foreman, Private, Army.
D. L. Larrimore, Sr. C. Engr. Aide, Private, Army.
M. B. Loeb, Jr. C. Engr., Cadet, Air Corps.
H. D. Lyles, Jr., C. Engr. Aide, Private, Air Corps.
H. D. Lynes, Jr., Jr. C. Engr., Private, Army.
B. B. Mabson, Jr., Sr. C. Engr., 1st Lieutenant, Engr. Corps.
P. K. Mandeville, C. Engr. Aide, Private, Army.
H. M. Martin, C. Engr. Aide, Private, Army.
M. O. Martin, Auto Mechanic, Army.
L. B. McCord, C. Engr. Aide, Cadet, Air Corps.
F. E. McCrary, Sr. C. Engr. Aide, Private, Army.
J. T. McDaniel, Prin. Mo. Eqp. Opr., Private, Army.
W. B. McDonald, Asso. C. Engr., Captain, Quartermaster Corps.
B. McEachern, C. Engr. Aide, Private, National Guard.
J. E. McElvaine, C. Engr. Aide, Private, Marine Corps.
J. M. McInnis, Jr. C. Engr., Private, Army.
F. O. McManus, Jr., Sr. C. Engr. Aide, Private, Army.
W. W. Medley, Pr. Mot. Equip. Co., Private, Army.
D. Meredith, Sr. C. Eng. Aide, Ordnance Dept., Army.
R. C. Miller, C. Eng. Aide.
C. R. Mitchell, Sr. Hwy. Foreman, Private, Army.
E. McL. Moore, Sr. C. Engr. Aide, Private, Army.
H. D. Moseley, Electrical Engr., 2nd Lieutenant, Field Artillery.
E. Y. Muckle, Sr. C. Engr. Aide, Private, Field Artillery.
L. E. Mullins, Jr. C. Engr., 1st Lieutenant, Field Artillery.
J. D. Oliver, C. Engr. Aide, P. Seaman, Naval Reserve.
H. Orr, Sr. C. Engr., Major, Field Artillery.
L. N. Owens, Jr. C. Engr., Yeoman, Navy.
J. F. Pack, Sr. C. Engr. Aide, C. M.1 C. Navy.
O. S. Patterson, C. Engr. Aide, Private, Army.
R. M. Paul, C. Engr. Aide, Air Corps.
M. C. Perry, C. Engr. Aide, Private, National Guard.
L. L. Persons, Sr. Clerk, 2nd Lieutenant, National Guard.
T. Phillips, Mo. Eqp. Opr., Private, Army.
M. L. Pierce, Jr., Asst. C. Engr., Private, Army.
W. E. Pierce, C. Engr. Aide, Private, Army.
R. E. Pilcher, Jr. C. Engr., Sergeant, Field Artillery, Army.
C. P. Poole, Sr. C. Engr. Aide, App. Seaman, Coast Guard.
F. E. Poole, Jr., Convict Guard, Private, Army.
L. E. Poole, C. Engr. Aide, Private, Army.
R. A. Poole, C. Engr. Aide, Private, Army.
H. P. Posey, Sr. C. Engr. Aide, Cadet, Air Corps.
W. J. Pritchett, Sr. C. Engr. Aide, Naval Reserves.
D. M. Ray, C. Engr. Aide, Private, Army.
J. E. Ray, Sr. Engr. Aide, Private, Air Corps.

J. R. Relfe, Asst. C. Engr., 1st Lieutenant, Army.
A. C. Rhodes, Jr., C. Engr. Aide, Private, Army.
W. H. Ripley, C. Engr. Aide, Private, Engineers.
E. T. Roberson, C. Engr. Aide, Private, Army.
C. H. Robertson, Sr. C. Engr. Aide, Private, Army.
W. E. Rowe, C. Engr. Aide, Private, Army.
P. W. Saffold, Jr., Sr. C. Engr. Aide, Cadet, Air Corps, Army.
P. D. Saunders, Jr., Sr. C. Engr. Aide, Private, Army.
G. E. Scott, Jr., C. Eng. Aide, Air Corps.
R. C. Searcy, Jr., Jr. C. Engr., Reserve Officer, Army.
R. E. Shaw, Jr. C. Engr., Private, Marines.
R. Sikes, Asst. C. Engr., Reserve Officer, Eng. Corps.
R. T. Simpson, C. Engr. Aide, Air Corps, Army.
L. C. Singley, C. Engr. Aide, Private, Army.
J. J. Speight, Jr., C. Engr. Aide, Air Corps.
R. W. Steen, Sr. C. Engr. Aide, Private, Army.
M. J. Stewart, Jr., Sr. Clerk, Private, Army.
B. J. Strickland, C. Engr. Aide, Private, Marines.
J. A. Tait, Sr. Steward, Private, Army.
J. W. Tatum, Utility Laborer, Private, Army.
K. G. Taylor, Asst. C. Engr., 1st Lieutenant, Field Artillery, Army.
H. O. Teague, C. Engr. Aide, Private, Army.
R. B. Teal, Sr. Engr. Aide, Private, Army.
B. Thompson, Sr. Clerk, Private, Army.
S. C. Thompson, Sr. Steward, Chief Commissary Steward, Navy.
J. F. Tisdale, Jr., C. Engr. Aide, Corporal, National Guard.
G. P. Tucker, Sr. C. Engr. Aide, Private, Army.
M. L. Vaughan, Sr. C. Engr. Aide, Private, Army.
F. T. Vickers, Sr. C. Engr. Aide, Private, Army.
J. B. Vinson, Sr. C. Engr. Aide, Private, Navy.
L. C. Walker, C. Engr. Aide, Private, Army.
J. R. Ware, C. Eng. Aide, Private, Army.
J. R. Waren, Auto Mechanic, Private, National Guard.
W. S. Watts, C. Engr. Aide, Private, Army.
L. Weathers, Jr. C. Engr., Private, Army.
P. D. Whetstone, Assoc. C. Engr., 1st Lieutenant, Engineers.
B. Whitcomb, Auto Mech. Helper, Private, National Guard.
O. H. White, C. Engr. Aide, National Guard.
W. M. White, C. Engr. Aide, Private, Army.
H. F. Williams, Jr. Engr., Private, Army.
B. Wilson, Prin. Mo. Eqp. Opr., Private, Army.
A. M. Wood, C. Engr. Aide, Private, Army.
A. L. Wright, C. Engr. Aide, 3rd Class Seaman, Navy.
H. T. Young, C. Engr. Aide, Private, Army.

OHIO

R. S. Beightler, Major General, Army, Director of Highways.
H. S. Perry, Lieut. Colonel, Intelligence, Engineer.
R. R. Litehiser, Lieut. Colonel, Field Artillery, Engineer.
J. Rees, Lieut. Colonel, Infantry, Engineer.
C. P. Smith, Major, War Dept. General Staff, Engineer.
E. W. Proctor, Major, Field Artillery, Inspector General.
A. H. Wilson, Major, Instructor, Engineer.
E. C. Guisinger, Major, Army, Instrumentman.
N. D. Moler, Major, Infantry, Engineer.
D. R. Austin, Major, Cavalry, Instrumentman.
H. L. Rupert, Major, Field Artillery, Engineer.
H. S. Everhart, Captain, Infantry, Engineer.
H. E. Hallock, Captain, Field Artillery, Engineer.
V. F. Hydaker, Captain, Army, Engineer.
C. M. Turner, Captain, Army, Instrumentman.
G. Rafferty, Captain, Army, Engineer.
A. A. Westrick, Captain, Army, Engineer.
T. E. Benson, Captain, Engineer's Corps, Instrumentman.
B. A. Froehle, Captain, Army, Draftsman.
T. D. Barnhouse, Captain, Army, Engineer.
W. A. Young, Captain, Army, Inspector.
R. E. Fisher, Captain, Engineer's Corps, Engineer.
H. Cole, Captain, Engineer's Corps, Engineer.
W. Belknap, Captain, Quartermaster Corps, Engineer.
W. D. Arnold, Captain, R. O. T. C., Engineer.
H. Anderson, Captain, Army, Engineer.
C. Bowers, 1st Lieutenant, Army, Engineer.
A. J. Friemoth, 1st Lieutenant, Engineer's Corps, Engineer.
S. Pritchard, 1st Lieutenant, Engineer's Corps, Engineer.
R. S. Deetz, 1st Lieutenant, Officer's Training School, Engineer.
W. R. Underwood, 1st Lieutenant, Infantry, Engineer.
E. L. Burrell, 1st Lieutenant, Field Artillery, Engineer.
R. L. Chambers, 1st Lieutenant, Army, Engineer.
C. Mengerink, 1st Lieutenant, Army, Engineer.
F. C. Redick, 1st Lieutenant, Army, Engineer.
G. B. Wing, 1st Lieutenant, Army, Landscape Architect.
D. J. Howell, 1st Lieutenant, Infantry, Instrumentman.
J. M. Unger, 1st Lieutenant, Army, Engineer.
G. B. Free, 1st Lieutenant, Army, Engineer.
H. A. Dve, 1st Lieutenant, Army, Rodman.
R. L. Hilty, 1st Lieutenant, Infantry, Chemist.
C. H. Shepard, 1st Lieutenant, Infantry, Engineer.
W. S. Dun, 1st Lieutenant, Army, Engineer.
F. E. Seaman, 2nd Lieutenant, Engineer's Corps, Engineer.
A. Trefny, Jr., 2nd Lieutenant, Field Artillery, Inspector.
C. White, 2nd Lieutenant, Engineer's Corps, Inspector.
R. S. Hall, 2nd Lieutenant, Field Artillery, Draftsman.
R. J. Jameson, 2nd Lieutenant, Army, Engineer.
D. E. Starkey, 2nd Lieutenant, Army, Engineer.
R. M. Shumaker, 2nd Lieutenant, Armored Engineers, Instrumentman.
R. H. Kramer, 2nd Lieutenant, Coast Artillery, Inspector.
J. Hewitt, 2nd Lieutenant, Army, Engineer.
A. F. Houser, 2nd Lieutenant, Army, Chemist.
R. S. Dexter, 2nd Lieutenant, Quartermaster Corps, Engineer.
W. F. Jung, 2nd Lieutenant, Signal Corps, Engineer Assistant.
L. P. Bowsher, Lieutenant, Army, Instrumentman.
R. Holland, Technical Sergeant, Engineer's Corps, Draftsman.
R. P. Heddleston, Master Sergeant, Army, Draftsman.
G. H. Louys, Staff Sergeant, Engineer's Corps, Instrumentman.
J. W. Koegel, Sergeant, Engineer's Corps, Draftsman.
G. Biggam, Corporal, Field Artillery, Rodman.
J. W. Boren, Civilian Employee, Engineer's Corps, Engineer.
E. M. Fetzer, Private, Infantry, Inspector.
W. H. Wood, Private, Army, Inspector.
A. P. Nicol, Private, Medical Corps, Engineer Assistant.
R. K. Wyss, Private, Coast Artillery, Rodman.
M. Birnbaum, Private, Engineer's Corps, Rodman.
J. Kleinhenz, Private, Army, Rodman.
R. J. Munger, Private, Field Artillery, Draftsman.
M. H. Felton, Private, Army, Rodman.
C. W. Lipphardt, Private, Army, Draftsman.
D. B. Walker, Private, Army, Rodman.
J. B. Warder, Private, Army, Draftsman.
R. B. Dean, Private, Army, Chainman.
R. Houghton, Private, Army, Rodman.
C. E. Stevens, Private, Army, Chairman.
L. R. Fussner, Private, Army, Inspector.
P. G. Kammerer, Private, Army, Chainman.
R. M. Kenney, Private, Army, Chainman.
G. Markland, Private, Army, Chainman.
L. L. Ripley, Private, Army, Instrumentman.
L. E. Niday, Private, Army, Project.
J. T. Porter, Private, Engineer's Corps, Inspector.
H. A. Hay, Private, Army, Rodman.
L. E. Cottrell, Private, Cavalry, Rodman.
J. A. Francis, Jr., Private, Infantry, Inspector.
B. Hummel, Private, Army, Inspector.
R. Mitchell, Private, Army, Draftsman.
R. W. Townsend, Private, Army, Inspector.
J. M. Russell, Ordnance Sec., Instrumentman.
W. C. Enderby, Army, Inspector.
H. Nelson, Army, Rodman.
A. E. Lincione, 2nd Lieutenant, Army Air Corps, Inspector.
E. C. Buhrer, 2nd Lieutenant, Army Air Corps, Rodman.
H. Isay, Bombardier, Army Air Corps, Tracer.
J. Edwards, Staff Sergeant, Army Air Corps, Chainman.
L. R. Kienele, Cadet, Army Air Corps, Draftsman.
W. McBride, Cadet, Army Air Corps, Inspector.
M. J. Warner, Jr., Cadet, Army Air Corps, Rodman.
C. C. Metcalf, Cadet, Army Air Corps, Draftsman.
H. O. Hart, Cadet, Army Air Corps, Rodman.
B. H. Baldwin, Cadet, Army Air Corps, Rodman.
C. M. Hayward, Cadet, Army Air Corps, Chainman.
D. L. Chaney, Private, Army Air Corps, Rodman.
K. Hannum, Private, Army Air Corps, Landscape Architect.
J. A. Crano, Private, Army Air Corps, Draftsman.
R. C. Clause, Ground Mechanic, Army Air Corps, Instrumentman.
W. H. Huffman, Army Air Corps, Rodman.
L. L. Watkins, Army Air Corps, Instrumentman.
R. Scheppers, Lieut. Sr. Gr., U. S. Naval Res., Civil Engr. Corps, Engineer.
P. Watson, Petty Officer, Navy, Inspector.
R. W. Gable, Petty Officer, Navy, Inspector.
L. A. Kovregg, Ensign, Naval Reserve, Inspector.
W. C. Sharpe, Ensign, Naval Reserve, Inspector.
C. W. Baxter, Ensign, Navy, Instrumentman.
F. G. Randall, C. M. 3rd Class, Navy, Engineer Assistant.
R. L. Barbor, Ensign, Naval Air Corps, Instrumentman.

The following employes are in the service but the rank and branch of service are not known:

C. H. Kruse, Assistant Right of Way Engineer.
R. Geise, Assistant Engineer.
T. Holzemer, Rodman.
G. Kridler, Rodman.
C. Taylor, Rodman.
J. P. Kyler, Bridge Inspector.
M. Hawks, Inspector.
T. Braswell, Inspector.
W. S. Smith, Chainman.
L. F. Dilley, Rodman.
U. Walters, Assistant Engineer.
H. L. Avery, Instrumentman.
R. M. Gregg, Landscape Inspector.
L. J. Prues, Draftsman.
C. C. Parsons, Inspector.
W. Sprague, Inspector.

ILLINOIS

E. R. Ailes, Jr. Highway Engineer.
C. W. Arnold, Assistant Highway Engineer.
C. L. Badger, Jr. Highway Engineer.
H. C. Becker, Jr. Highway Engineer.
H. W. Bieritz, Jr., Jr. Highway Engineer.
G. M. Booth, Jr., Jr. Highway Engineer.
M. P. Boulden, District Engineer Design.
D. A. Branigan, Traffic Engineer.
D. R. Brewster, Jr. Highway Engineer.
R. C. Brewster, Assistant Highway Engineer.
F. P. Brock, Assistant District Engineer Materials.
L. J. Burg, Jr. Highway Engineer.
J. I. Dalrymple, Jr. Highway Engineer.
E. Danner, Assistant Highway Engineer.
R. E. Dunnington, Jr. Highway Engineer.
F. R. Davidson, Jr. Highway Engineer.
O. Day, Assistant Highway Engineer.
K. DeYoung, Jr. Highway Engineer.
L. Elgenson, Jr. Highway Engineer.
V. Esposito, Jr. Highway Engineer.
W. D. Fooks, Jr. Highway Engineer.
R. J. Furbeck, Assistant Highway Engineer.
R. H. Gardner, Jr. Highway Engineer.
J. W. Gee, Jr. Highway Engineer.
B. L. Goepfert, Jr. Highway Engineer.
M. J. Goldfarb, Jr. Highway Engineer.
J. P. Grogan, Jr. Highway Engineer.
W. E. Gronberg, Assistant Highway Engineer.
J. R. Gulick, Jr. Highway Engineer.
C. A. Hamlin, Assistant Highway Engineer.
R. F. Haug, Jr. Highway Engineer.
E. W. Heilig, Jr. Highway Engineer.
H. J. Heuer, Jr. Highway Engineer.
H. A. Hollingshead, Assistant Highway Engineer.
R. F. Hlavek, Jr. Highway Engineer.
B. L. Jakaistis, Jr. Highway Engineer.
A. Jensen, Jr. Highway Engineer.
J. W. Jogl, Jr. Highway Engineer.
J. G. Keller, District Maintenance Engineer.
J. E. Kellogg, Jr. Highway Engineer.
W. L. Kleinpaste, Jr., Jr. Highway Engineer.
F. W. Kraft, Assistant Chief Landscape Engineer.

O. W. Kriege, Jr. Highway Engineer.
A. B. Litiven, Assistant Highway Engineer.
C. C. Madden, Jr. Highway Engineer.
K. Maguire, Jr. Highway Engineer.
R. H. Major, Assistant Highway Engineer.
E. W. Menk, Jr. Highway Engineer.
P. Michener, Assistant Highway Engineer.
J. C. Monahan, Jr. Highway Engineer.
C. S. Monnier, Jr. Highway Engineer.
A. P. Mueller, Assistant Highway Engineer.
M. G. Peter, Assistant Highway Engineer.
W. M. Phillips, Assistant Highway Engineer.
C. E. Powell, Jr. Highway Engineer.
H. C. Poyer, District Landscape Engineer.
G. H. Reynolds, Jr. Highway Engineer.
C. Rice, Jr. Highway Engineer.
V. M. Romine, Assistant Highway Engineer.
G. K. Ray, Jr. Highway Engineer.
O. L. Rufener, Assistant Highway Engineer.
R. F. Schilsky, Jr. Highway Engineer.
B. T. Schwar, Jr. Highway Engineer.
J. A. Shaneman, Jr. Highway Engineer.
C. L. Shively, Jr. Highway Engineer.
E. T. Simonds, Jr. Highway Engineer.
R. K. Snethen, Jr. Highway Engineer.
S. G. Steers, Jr. Highway Engineer.
R. D. Stephens, Junior Chemist.
D. M. Stowers, District Traffic Engineer.
A. M. Sterba, Jr. Highway Engineer.
A. E. Thomas, Jr. Highway Engineer.
C. C. Travis, Jr. Highway Engineer.
R. E. Tucker, Jr. Highway Engineer.
M. VanEtten, Assistant Highway Engineer.
W. E. Van Winkle, Jr. Highway Engineer.
W. M. Wagner, Jr. Highway Engineer.
C. O. Watkins, Assistant Highway Engineer.
A. F. Wiedeman, Jr. Highway Engineer.
L. J. Wiltrakis, Jr. Highway Engineer.
R. A. Wilkinson, Jr. Highway Engineer.
C. E. Wright, Jr. Highway Engineer.
E. N. Wyman, Assistant Highway Engineer.
G. Younkin, Jr. Highway Engineer.
J. B. Yowell, Jr. Highway Engineer.
V. Esposito, Jr. Highway Engineer.
A. Jensen, Jr. Highway Engineer.
A. B. Litvien, Assistant Highway Engineer.
R. H. Major, Assistant Highway Engineer.
C. E. Narup, Jr. Highway Engineer.
F. B. Sebastian, Jr. Highway Engineer.
J. B. Yowell, Jr. Highway Engineer.

MICHIGAN

L. A. Andriacchi, Asst. Director-Planning & Traffic, Army.
F. A. Anderson, Senior Instrumentman, Captain, Army.
H. N. Arnold, Project Engineer, Army.
S. W. Bassford, Chainman, Corporal, Army.
R. Baxter, Chainman, Army.
F. S. Benjamin, Chainman, Army.
E. Benson, Inspector, Army.
J. C. Brehler, Laboratory Technician, Army.
L. Cannella, Chainman, Army.
G. D. Card, Cartographic Engineer, Army.
S. Cardone, Testing Engineer, Army.
F. Carrier, Chainman, Army.
R. D. Chenez, Draftsman, Army.
B. A. Cyberski, Field Traffic Investigator, Army.
A. Davis, Physical Testing Engineer, Lieutenant, Army.
H. A. Douville, Inspector, Army.
W. R. Downey, Survey Chief, Army.
R. F. Durfee, Inspector, Lieutenant, Army.
G. L. Dunkirk, Draftsman, Army.
A. S. Frink, Chainman, Army.
L. H. Gay, Bridge Inspector, Lieutenant, Army.
M. L. Germaine, Bridge Draftsman, Sergeant, Army.
G. K. Gravelle, Traffic Engineer, Lieutenant, Army.
E. Greenbaum, P. W. A. Engineer, Captain, Army.
F. Hartnacke, Traffic Safety Engineer, Lieutenant, Army.
J. R. Horner, Bridge Inspector, Army.
F. Jaskiewicz, Chainman, Army.
P. Jozwiak, Draftsman, Army.
S. Johnson, Bridge Draftsman, Army.
R. Kent, Inspector, Army.
R. F. Killeen, Draftsman, Army.
D. Kilpatrick, Laboratory Testing Aide, Lieutenant, Army.
E. Kozlowski, Draftsman, Army.
J. L. Kraus, Draftsman, Lieutenant, Army.
J. Katcham, Bridge Inspector, Army.
R. M. Lickly, Cartographic Engineer, Lieutenant, Army.
H. McCarthy, Senior Instrumentman, Army.
F. Makus, Chainman, Army.
A. J. Marusich, Draftsman, Lieutenant, Army.
L. W. Mabbott, Physical Research Engineer, Army.
L. H. Multhaupt, Chainman, Pfc., Army.
C. V. Opdyke, Bridge Designer, Army.
E. E. Osmun, Bridge Designer, Captain, Army.
A. J. Parker, Bridge Draftsman, Lieutenant, Army.
E. Przbylski, Chainman, Army.
D. Rader, Bridge Designer, Lieutenant, Army.
H. L. Ransom, Designer, Army.
R. H. Reighard, Senior Instrumentman, Army.
H. Rudzinski, Chainman, Army.
W. C. Smith, Chainman, Army.
J. Symonds, Landscape Inspector, Army.
R. Tellman, Bridge Designer, Captain, Army.
E. E. Thayer, Project Engineer, Lieutenant, Army.
T. J. Thomaskovich, Chainman, Army.
J. P. Thompson, Bridge Designer, Captain, Army.
M. H. Thompson, Estimate Engineer (Bridge), Major, Army.
J. L. Thornton, Junior Instrumentman, Army.
A. Ueck, Chainman, Army.
J. Upham, Field Traffic Investigator, Lieutenant, Army (Air Corps).
J. Watts, Bridge Draftsman, Army.
D. Wessels, Chainman, Army.
K. Wickham, Inspector, Army.
R. M. Christie, Draftsman, Army.
J. M. Driscoll, Chainman, Army Air Corps.
J. Hauser, Bridge Designer, Lieutenant, Army Air Corps.
J. Van Dis, Bridge Designer, Lieutenant, Army Air Corps.
H. Boudreau, Inspector, Able Seaman, Navy.
P. H. Finan, Chainman, Navy.
J. Hauser, Bridge Designer, Lieutenant, Navy.
D. Henry, District Forester, Lieutenant Commander, Navy.
R. Montgomery, Bridge Designer, Ensign, Navy.
C. E. Smith, Chainman, Navy.
R. Wisneski, Inspector, Navy.
L. E. Kimball, Senior Instrumentman, Navy Air Corps.
T. E. Kane, Inspector, Navy Air Corps.

MINNESOTA

C. C. Colwell, Civil Engr. V, National Guard.
B. D. Ayers, Engr. Aide III, National Guard.
F. L. Campbell, Civil Engr. I, National Guard.
G. J. Carlson, Engr. Aide III, Coast Artillery Reserve.
D. Clark, Engr. Aide II, Signal Corps Reserve.
J. E. Davidoff, Stud. Hwy. Engr. Aide, Coast Artillery Reserve.
S. Fidelman, Engr. Aide III, Coast Artillery Reserve.
R. E. Frederickson, Stud. Hwy. Engr. Aide.
H. W. Hansen, Stud. Hwy. Engr. Aide, Army.
E. J. Heinen, Stud. Hwy. Engr. Aide, Signal Corps Reserve.
M. E. Hermanson, Civil Engr. I, National Guard.
S. Johnson, Stud. Hwy. Engr. Aide, Army Air Corps.
A. M. Knappen, Engr. Aide II, Army Air Corps.
F. A. McCulloch, Engr. Aide III, National Guard.
M. Moen, Engr. Aide III, Naval Reserve.
A. Ronbeck, Engr. Aide III.
A. L. W. Anderson, Engr. Aide III, Coast Artillery Reserve.
W. B. Marschner, Civil Engr. I, Army Reserve.
O. M. Rufsvold, Civil Engr. III, Army Reserve.
B. L. Armstrong, Engr. Aide II, U. S. Army.
H. P. Beschenbossel, Civil Engr. I, National Guard.
W. Carr, Engr. Aide II, Army.
O. W. Dahl, Civil Engr. I, Coast Artillery Reserve.
S. Dains, Engr. Aide II, Army.
H. R. Davenport, Engr. Aide II, Army.
F. J. Deegan, Engr. Aide II, Army.
D. Gander, Engr. Aide II, Army.
L. Grace, Engr. Aide II, Army.
K. F. Greiner, Engr. Aide III, Naval Reserve.
H. A. Holmstrom, Civil Engr. I, Army Reserve.
E. G. Hutterer, Engr. Aide II, National Guard.
L. H. Korstad, Engr. Aide III, Army Reserve.
F. Kelly, Engr. Aide III, Marine Corps.
E. C. Knutson, Engr. Aide II, Army.
G. Kristen, Engr. Aide III, Army.
F. W. Kuhfeld, Civil Engr. I, Army Reserve.
V. Laine, Engr. Aide II, Army.
R. Lenich, Engr. Aide I, Army.
S. Lewis, Engr. Aide II, Army.
E. J. Lundheim, Engr. Aide III, Coast Artillery Reserve.
W. E. Matthews, Engr. Aide II, Army.
F. L. Paul, Engr. Aide III, Army.
H. J. Rodgers, Engr. Aide II, National Guard.
C. Schoonover, Engr. Aide II, Army.
A. T. Schultz, Engr. Aide II, Army.
J. E. Shelrud, Engr. Aide II, Army.
E. Wahlstrom, Engr. Aide II, Army.
R. V. Bernier, Engr. Aide III, Army Engr. Reserve.
J. P. Goettl, Engr. Aide III, Coast Artillery Reserve.
D. R. Hefti, Engr. Aide III, National Guard.
F. J. Pawlak, Engr. Aide III, Army Reserve.
J. J. Lieb, Civil Engr. I, Minnesota Defense Force.
M. C. Solberg, Civil Engr. II, Army Air Corps.
K. Caswell, Jr., Engr. Aide II, Naval Reserve.
G. L. Pine, Engr. Aide II, Army.
J. F. Jeppeson, Engr. Aide II, Navy.
L. E. Matson, Engr. Aide I, Army.

NEBRASKA

J. Enslow, Jr. Draftsman, Army, 1st Lieutenant.
B. B. Miltonberger, Rodman, Army, Colonel.
R. St. John, Assoc. Engr., Army, 2nd Lieutenant.
R. J. Wedner, Proj. Engr., Army, 2nd Lieutenant.
A. J. Andreson, Rodman, Army, Lieutenant.
W. F. Brown, Supervisor, Army.
H. M. Bixby, Assoc. Engr., Army, 2nd Lieutenant.
J. Carney, S E A.
R. J. Evans, J E A, Army, Private.
L. Frisbie, S E A, Army, 2nd Lieutenant.
M. Gabel, Draftsman, Army, Private.
K. P. Hoffman, Jr. Engr., Navy, Petty Officer.
R. J. Lundgren, E A, Navy, Petty Officer.
P. R. Nelson, E A, Navy, Petty Officer.
M. Odvarka, J E A, Navy, 2nd Lieutenant.
M. Vlach, Jr. Engr., Navy, Petty Officer.
R. H. Wells, Assoc. Engr., Army, 2nd Lieutenant.
V. Wink, E A, Army, Private.
R. C. Alt, Jr. Eng. Ass't, Army, Com. Officer.
L. Barker, Draftsman, Army, 2nd Lieutenant.
F. W. R. Brown, S E A, Army, 1st Lieutenant.
G. H. Carrithers, Sr. Engr., Navy, Lt. Commander.
L. H. Cunningham, Sr. Eng. Draft., Army, 1st Lieutenant.
R. W. Devoe, Jr., J E A, Army, Private.
D. C. Erickson, Sr. Engr., Army, 1st Lieutenant.
F. S. Gantt, S E A, Army.
A. C. Grant, E A, Army.
T. J. Kastle, Jr. Engr., Army, Com. Officer.
W. H. Larson, Inspect.
A. T. Lobdell, Adm. Engr., Army, Lt. Col.
W. L. Crosson, Maint. Fore., Army, Captain.
F. L. Rastede, Br. Draft., Army, 1st Lt.
C. Salem, Eng. Ass't, Army, 2nd Lt.
P. Schluckebier, Eng. Ass't, Army.
E. C. Richardson, Army, Captain.

(Reports from other states will be printed in the July issue.)

"Sealed" Wood Deck Construction

LONGER service life and greater loading capacity are two advantages claimed for a new system of wood deck construction, developed and applied during the past six years to bridges of Fresno County, California.

Seven miles of wood decking, surfaced with asphalt, serve the trucks and autos of vineyard owners and agricultural workers in this ranking fruit-growing sector—the center of America's wine industry. Of the 7,000 city and county bridges, timber construction is used in approximately 90 percent.

To stop the fungus of dry rot from doing damage between the deck layers—the spot most vulnerable to attack by decay — the county builds new decks by "floating" the top longitudinal decking into place with grade "E" asphalt, literally sealing it to the bottom transverse decking.

Another safeguard against decay is set up by resting the decking on Wolmanized 4 in. x 16 in. Douglas fir stringers. From the condition of such "sealed" decks now in service on new or rebuilt structures it is expected that a service of from 15 to 18 years will be obtained as compared to 10 to 12 years for older and more conventional decks.

Construction view of double decking, Fresno County Bridge

The use of treated stringers has also proven an effective aid in combating a new danger—termite attack. A gradual spread of subterranean termites northward from the Southern Califronia sector was first noticed in Fresno four years ago by a maintenance crew member who saw a woodpecker hard at work on the end of an untreated stringer. Investigation disclosed termite activity which had progressed upward into the deck.

No termite damage has been discovered in wood bridges and culverts built with Wolmanized stringers. These stringers, plus the use of creosoted and steel "H" piling, combine to form an effective barrier, blocking termite passage into the superstructure.

Pouring hot asphalt on the 3-in. by 12-in. transverse decking before "floating" the longitudinal decking into place

A.S.T.M. to Be Asked to Approve New Standard.—At the 45th annual meeting of the American Society for Testing Materials at Atlantic City, N. J., June 22-26, Committee C-9 on Concrete and Concrete Aggregates will ask the approval of the Society of several new proposed standards, covering waterproof papers for curing concrete, methods of sampling fresh concrete, methods of measuring lengths of drilled concrete cores, and test for air content of freshly mixed concrete.

Reconstruction of Old Pavements on Heavily Traveled Highways

By E. T. BAKER
Senior Contract Engineer
Pennsylvania Department of Highways

RECONSTRUCTION of old pavements on heavily traveled highways in Pennsylvania is a serious problem, and it is assumed that other states are confronted with similar problems.

On Pennsylvania's state highway system of 40,510 miles, it has been found necessary to classify the highways on the basis of the daily average yearly traffic. The state follows a definite policy for reconstruction of highways on which the traffic is in excess of 1,500 cars per day. To some engineers the reconstruction of such highways with traffic of less than 5,000 cars may not be a problem, but in Pennsylvania the widening and reconstruction of narrow two-lane pavements requires considerable study.

Old Large Low Cost Road Program

The original construction of a large percentage of these roads was prior to 1927 at which time, through necessity, the department had to obtain the maximum mileage of improved roads with the limited funds available.

Pavements 16 feet and 18 feet in width, constructed with a bituminous surface course on a light flexible base or of reinforced concrete with a light section, generally followed the existing right-of-way. Relocations were made in a few instances, but they were of a minor nature and did not keep abreast of the rapid increase in traffic requirements. Grading quantities were kept to the minimum and the engineer was required to economize wherever possible.

Faced with these conditions, we have adopted several methods and employed various means to reconstruct old pavements, utilizing as much as possible of the original investment. In numerous cases, however, the increase in traffic, the topography, or the restricted right-of-way on the original alignment makes it necessary to relocate for through traffic, in which case the old road has reverted to the local authorities for their use. In a few cases the relocation has been used as a one-directional road and the old road for traffic in the opposite direction.

The principal methods used, rather than a detailed description, and some views of pavement sections adopted and results obtained will indicate the character of effort employed to reconstruct the old heavily traveled pavements.

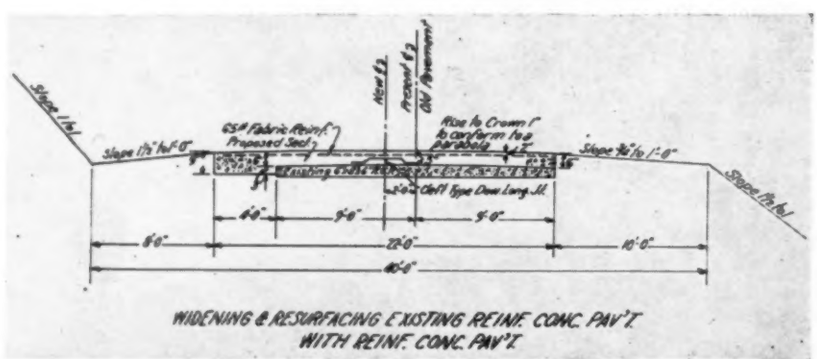
Two-Lane Pavements

Highways which accommodate 1,500 to 5,000 vehicles per 24-hour day should have a minimum paved width of 22 feet and shoulders 8 to 10 feet in width. However, where the total traffic is 4,500 to 5,000 or where the percentage of truck traffic is abnormal and the total traffic is above 3,500 vehicles, a 24-foot pavement is specified. On some of the main highways where the daily traffic does not reach 5,000 vehicles but where there is a constant movement of large trucks and truck-trailers, three-lane pavements are being provided.

The type of pavement is determined by character and amount of traffic, the condition and service record of the existing pavement, the location of the work, the soil conditions, and the availability of materials.

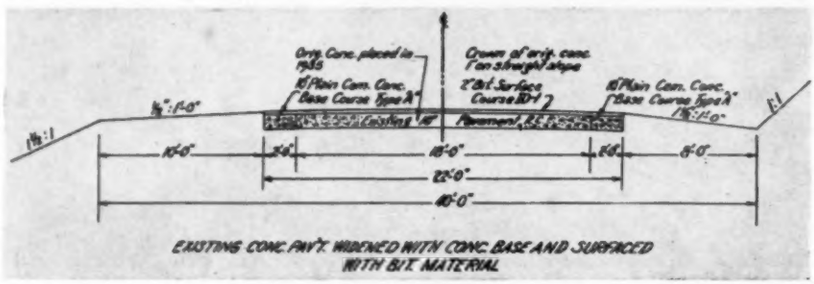
During the past depression the state specified in numerous cases cold-laid plant-mixed bituminous concrete or bituminous penetration surfaces on flexible bases of local field or ledge stone napped in place in order to use the maximum amount of local labor on contracts, department force work and W.P.A. projects.

Six examples of methods used to secure 22 and 24-foot pavements are discussed in paragraphs numbers 1 to 6 herewith.



WIDENING & RESURFACING EXISTING REINF. CONC. PAV'T. WITH REINF. CONC. PAV'T.

Fig. 1



EXISTING CONC. PAV'T. WIDENED WITH CONC. BASE AND SURFACED WITH BIT. MATERIAL

Fig. 2

(1) A typical section, figure 1, has been used in widening and resurfacing with reinforced concrete the existing reinforced concrete pavement. Pennsylvania has a limited mileage of this design in the western part of the state. Some transverse cracks have developed but there have been very few longitudinal cracks develop either over or adjacent to the edge of the old pavement. The reinforcing used weighs approximately 65 lb. per 100 square feet of pavement and consists of No. 0 gauge wire placed transversely on 6-inch centers with tie wires of No. 6 gauge on 12-inch centers.

(2) The typical section, figure 2, has been used for widening the existing reinforced concrete pavement with a plain concrete base course and two inches of hot plant-mixed bituminous concrete with seal coat over the existing concrete pavement and the new concrete base course.

(3) Figure 3 shows a typical section for widening the existing reinforced concrete pavement with a flexible base of stone or slag and two inches of cold-laid plant-mixed bituminous concrete over the existing concrete pavement and the new flexible base course.

The state has generally used the cold-laid plant-mixed bituminous concrete of the H-class on both the flexible and rigid bases.

The cross section, figure 4, indicates the method used in providing ¼-inch to ⅜-in. superelevation per foot of pavement width on these original concrete pavements which were constructed on curves of various degrees without superelevation or removal of the normal 2-inch crown. A similar section has been used on projects where the widening and resurfacing was accomplished with reinforced concrete.

(4) Widening of the existing macadam pavement with a flexible base 8 inches to 10 inches in depth. On projects of this type, it is generally necessary to thoroughly scarify and reshape the existing pavement. A bituminous penetration surface or a cold-laid plant-mixed bituminous concrete is placed over the reshaped pavement and the new base.

(5) Figure 5 shows the typical section used on relocations and in replacement of existing pavement with 22-foot or 24-foot reinforced concrete pavement. The depth of the concrete is usually nine inches. A straight slope of 0.1 inch per foot is provided. On some projects where the truck traffic is light and other conditions are favorable, an 8-inch uniform depth pavement is specified.

(6) On normal two-lane highways where there is considerable truck traffic, the state provides, as shown by figure 6, the third lane of pavement in mountainous territory to relieve traffic congestion. This diagram shows plan and profile for the additional pavement on each side and over the crest of the mountain where the alignment and limited sight distance necessitates overlapping of the additional lanes.

This widening has been accomplished with flexible bases and bituminous surfaces, also reinforced concrete, depending on the local conditions.

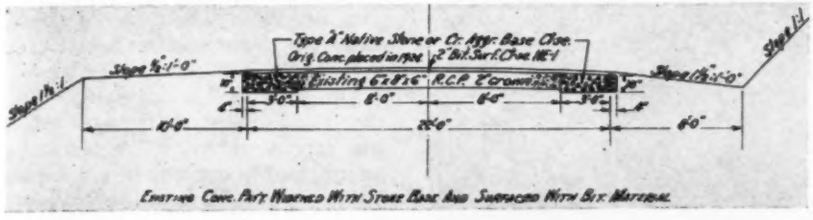


Fig. 3

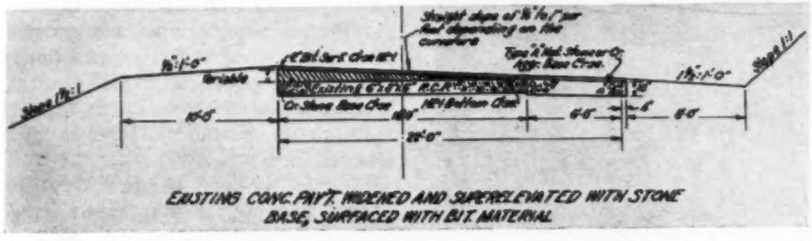


Fig. 4

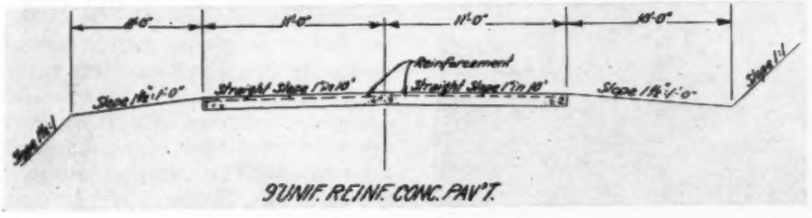


Fig. 5

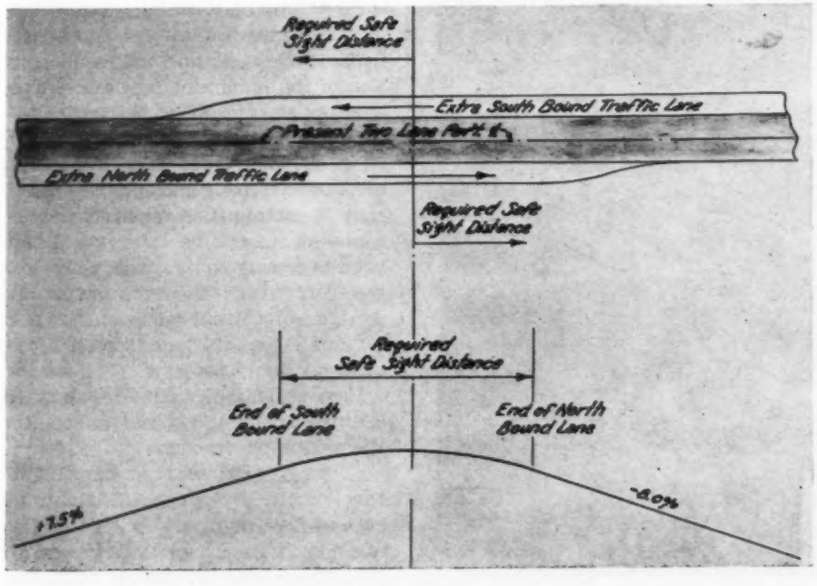
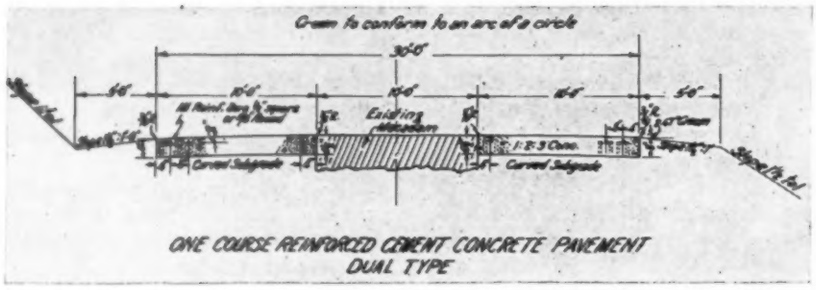


Fig. 6

Three-Lane Pavements

Highways which accommodate from 5,000 to 10,000 vehicles per 24-hour day should be of three-lane width. When the traffic is less than 7,500 vehicles, adequate passing sight distance of sufficient length should be available at reasonable intervals. When the



ONE COURSE REINFORCED CEMENT CONCRETE PAVEMENT
DUAL TYPE

Fig. 7

Fig. 8

Fig. 9

Fig. 10

traffic is in excess of 7,500 vehicles, adequate passing sight-distance should be provided throughout or the pavement should be widened to four lanes.

Prior to 1939, the width of three-lane pavements constructed was 30 feet. Since then, the minimum and prevailing width is 33 feet although the use of a 12-foot center lane for passing is justified in some projects. Where the percentage of large trucks and truck trailers is abnormal, lanes 12 feet in width can be well utilized. The shoulders should be at least 8 feet wide in cut sections and 10 feet wide in fill sections.

The type of pavement for these three-lane highways is governed by the service record of the existing pavement, soil conditions and availability of material and labor. During the recent depression, considerable mileage of flexible type base course with a bituminous surface was used to aid in absorbing the labor surplus. Reinforced concrete pavements have a 9-inch depth. Flexible bases are 10 inches or 12 inches in depth and the bituminous surfaces 2 inches or 3 inches in depth.

During the past 17 years, Pennsylvania has built 905 miles of three-lane pavements.

On some of our less important routes where the present traffic justifies a three-lane pavement throughout and where conditions such as railroad grade crossings, built-up communities and expensive bridge construction necessitates postponement of this work, we have provided at reasonable intervals sections of three-lane pavement of sufficient length with adequate passing sight-distance. This might be considered "Unfinished Business," but the sections of three-lane pavements provided have definitely relieved the traffic congestion and the reconstruction of the remaining sections of two-lane pavement can be postponed.

On some of the first projects constructed with three lanes, the state did not exercise sufficient care in design to obtain the required passing zones at reasonable intervals. It has been necessary to paint traffic lines in the center of these pavements for sections of considerable length. It is fortunate that this condition does not exist on many projects.

Figures 7 to 16, inclusive, show six examples or methods used in securing three-lane pavements.

(1) A typical section, figure 7, of the Lincoln Highway U. S. Route 30, east of Downington was built in 1925 and is now in service. It is one of the first three-lane pavements built. The existing macadam pavement was sal-

vaged for a width of 10 feet and the two-lanes of reinforced concrete pavement were placed along the outside. The depth of the concrete adjacent to the macadam is only 6½ inches. The general alignment and grades of the existing macadam were considered satisfactory and very little reconstruction of the center lane was necessary. The picture, figure 8, of the pavement was taken in 1927. In the years following, the center lane was surface-treated several times which resulted in building up an excessive crown. In 1937 this center lane was scarified and reshaped to reduce the crown. Two inches of cold-laid plant-mixed bituminous concrete was placed thereon. As traffic increased, the maintenance of shoulders adjacent to the 10-foot concrete lanes became a serious problem, and in 1938, the department sponsored a W.P.A. project to place a napped stone base and two inches of cold-laid plant-mixed bituminous concrete on the shoulders. We now consider the effective width 33 feet to 34 feet. Figure 9 is a view of the pavement as it is today.

(2) Figure 10 is a view of relocated U. S. Route 6 between Scranton and Carbondale, Lackawanna County, sponsored by the state and built by W.P.A. The type of construction is 10-inch napped local stone base with 2 inches of cold-laid plant-mixed bituminous concrete 33 feet wide on a 50-foot graded section.

(3) The picture, figure 11, shows widening of 20-foot reinforced concrete pavement with 10-inch napped local stone base and 2 inches of cold-laid plant-mixed bituminous concrete 12 feet in width. This section is about 5 miles in length and is situated over the mountain on Traffic Route 29, Lehigh and Schuylkill counties. The work was done as a state-sponsored W.P.A. project in 1939. This extra lane over the mountain relieves traffic on this heavy coal-hauling route.

(4) The view, figure 12, is of the William Penn Highway, U. S. Route 22, prior to its reconstruction in 1934. Figure 13 is a view of the same section after completion as a three-lane dual type pavement. The outside lanes are reinforced concrete 10 in. by 8 in. by 10 in. in depth and 10 feet in width. The center lane is 10-inch napped local stone with two inches of cold-laid plant-mixed bituminous concrete 10 feet in width. The poor condition of the original macadam, the variation in its profile and cross section did not justify its reclamation in reconstructing the center lane. An unlimited supply of good local stone was availagle for a new flexible base.

Fig. 11

Fig. 12

Fig. 13

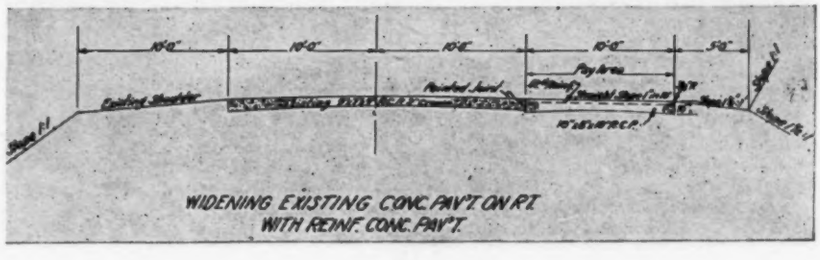


Fig. 14

(5) The typical section of the old concrete pavement and the widening provided in 1934 on the Lincoln Highway, U. S. Route 30 east of Lancaster City, is shown by figure 14. The existing 20-foot concrete pavement constructed in 1927 was in very good condition and had a high salvage value. The traffic on this portion of the route justified a three-lane pavement with adequate passing sight distance throughout. Within a distance of seven miles on this project there were six existing vertical curves on which the sight distance was insufficient. Adjacent real estate improvements had to be considered. Comparative estimates including construction, property damage and maintenance were prepared to determine which method of reconstruction should be used: (*a*) Widening of existing 20-foot concrete to provide four traffic lanes, or (*b*) scrapping of the original 20-foot pavement by lowering the grade and building a new 30-foot concrete pavement. On five sections totaling one and one-half (1½) miles the existing 20-foot pavement was widened to 40 feet. On the remaining section about 1,000 feet in length, the existing pavement was replaced with 30 feet of concrete on the lowered grade.

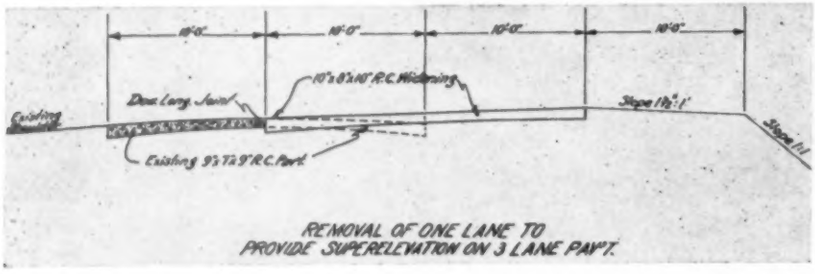


Fig. 15

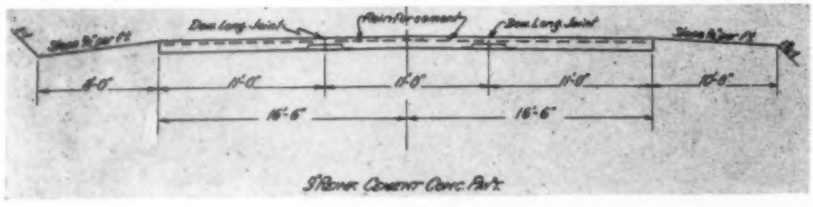


Fig. 16

Fig. 17

Fig. 18

On this improvement, the state was taking advantage of an abandoned trolley track area adjacent to the 20-foot pavement. At the time of the original construction in 1927, the 2-inch crown was not removed on the 2-degree and 3-degree curves. Where the proposed 10-foot widening was to be placed on the outside of these curves, it was necessary to remove one 10-foot lane of the existing pavement to obtain a satisfactory cross section and sufficient superelevation. Figure 15 is typical section showing this replacement.

(6) Figure 16 is a typical section of Pennsylvania's present design for a new three-lane reinforced concrete pavement, 33 feet in width on a graded section 49 feet to 53 feet wide.

These six (6) examples show the different combinations used in the reconstruction of Pennsylvania's highways to provide three-lane pavements. Since 1925, department engineers have been carefully studying the behavior of local and foreign traffic using these three-lane pavements. We are convinced that there is full justification for the continued construction and use of three-lane pavements of adequate design.

The flexible center lane of the dual type pavements settle along the edges adjacent to the concrete and require continual maintenance to keep them flush with the rigid pavement. This settlement is especially noticeable where new flexible base courses were provided. The amount of settlement varies in depth and necessitates repeated corrective measures.

On a few dual type projects, a concrete base course was provided in lieu of the flexible base in the center lane. On some of these projects a hot plant mixed bituminous concrete was used. While this design is satisfactory, the construction cost is higher and its use is restricted to localities where such material can be readily obtained for both construction and maintenance.

On some of these projects with rigid base, we used a cold-laid plant-mixed bituminous concrete of the H-class. This type of surface is porous, and until well sealed under traffic surface water penetrated through and became trapped on the concrete base.

After carefully considering the advantages and the disadvantages of these dual type pavement designs, the department decided in 1939 to discontinue additional construction of dual type except under extenuating circumstances.

Four-Lane Pavements

There are very few highways in Pennsylvania outside of city limits on which the traffic demands more than four lanes. The state constructed 334 miles of four-lane pavements 31 miles of which are divided highways. It has constructed 122 miles of pavement consisting of five or more traffic lanes.

With the exception of multiple lane pavements through business areas of municipalities, our recent designs for four-lane pavements include a raised paved divisor having a minimum width of two feet.

The minimum width of traffic lane specified on these four-lane pavements is eleven feet, and the majority of these roads now in service have eleven-foot lanes. The present tendency is to increase the width of traffic lanes to twelve feet on the sections of highway where the number of large trucks and truck trailers is comparatively high.

The general procedure used in providing four-lane pavements does not differ from that employed in the reconstruction of two- and three-lane pavements.

Rigid type pavements are generally used in new construction. However, on projects which are sponsored with W.P.A. labor, we have provided heavy flexible bases of napped stone with a bituminous surface.

Seven examples of methods used in securing four-lane pavements are explained below and illustrated with figures 17 to 26, inclusive.

(1) The picture, figure 17, is of the Lincoln Highway, U. S. Route 30 west of Philadelphia City. This four-lane dual type pavement, 40 feet in width, was built in 1925 and is still in service. The construction in 1925 utilized the existing macadam for the center lanes, 20 feet in width. The concrete in the outer lanes has a depth of 6½ inches adjacent to the macadam and 8 inches at the curb. This center lane has been resurfaced since 1925.

(2) Figure 18 is a picture of the Lincoln Highway, U. S. Route 30, at the western terminus of the Pennsylvania Turnpike. On this four-lane divided highway built on relocation, we provided a six foot earth median strip adjacent to a 10-foot concrete lane. Top soil was placed in this area with the intention of having a grassed median strip. This design proved unsatisfactory from both a maintenance and operating standpoint.

(3) The 44-foot pavement, shown in figure 19, is a direct connection between U. S. Route 22 and the Indiantown Gap Reservation. The existing 18 ft. macadam pavement was widened with a 10-inch napped local stone base and a 2-inch bituminous penetration surface. This work was done with W.P.A. labor on a state sponsored project.

(4) The section, figure 20, shows an existing 18-foot concrete pavement widened 15 feet on each side with a 12-inch napped stone base. A rein-

(*Continued on page* 50)

Fig. 19

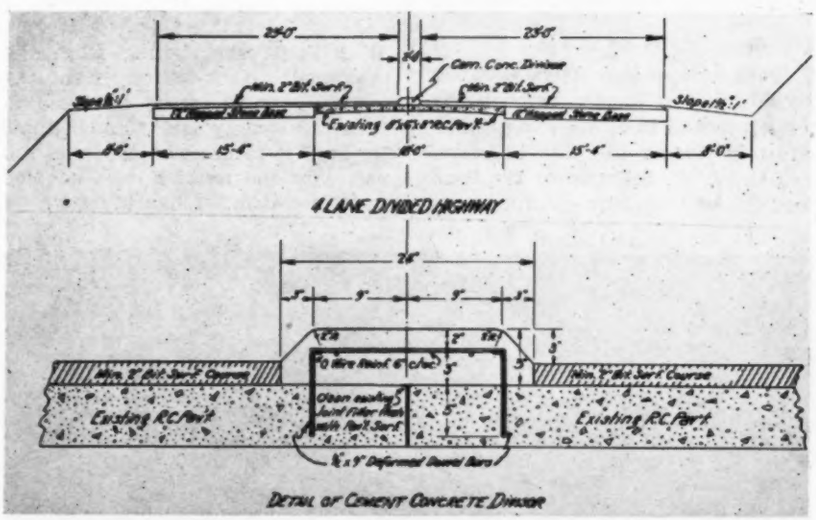


Fig. 20

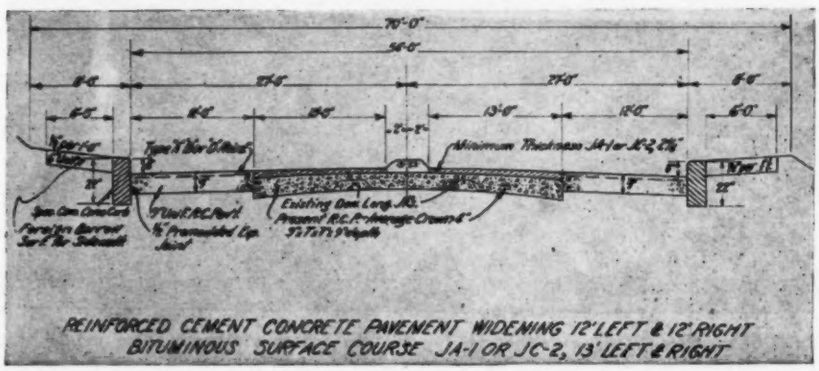


Fig. 21

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ Government arsenals are using an unusual wheel assembly on trucks transporting explosives, enabling these trucks to run up to 60 miles per hour on either highway or railroad track. In addition to special non-skid tread tires, flanged "railroad type" wheels are mounted ahead of front rubber tired wheels . . . enabling the truck to "ride the rails." Lessened jar and jolt is claimed to make for safer handling of explosives.

• •

¶ Work for approximately 15,000,000 people has been created through the development of 15 of America's major industries during the past 62 years, says Dr. J. W. Stillman of Du Pont Co. "One out of four gainfully employed owes his job wholly or partly to scientific research." To go that one better, let us remark that work for 80,000,000 Americans has been created by Schicklegruber and Tojo. And in a lot less time than 62 years.

• •

¶ Signs on the rear of trucks:
"Watch the Man Behind the Man In Front of You"
"Hit me Gently, I'm Full of Pie"

• •

¶ I keep remembering what the rawboned, black-haired Kentucky mountaineer who rode with me in Breathitt County said: "Fotched in." He used it to describe anything not native to the zone. I have adopted it. "Fotched in." I like it.

Ruins of adobe officers' quarters at Ft. Tejon in the Tehachapi Mountains on the highway connecting northern and southern California. Jefferson Davis, prior to his election as president of the Confederate States of America, was stationed in one of these adobe huts while an officer in the United States Army. Picture obtained from Santa Fe Railway

¶ Forward and Upward!

God of Thunder, Lord of Might,
Rend asunder, shatter, smite,
The chains of slavery.
Foes can never, in Thy Sight,
Live to plunder, darken, blight,
The Torch of Liberty.

Despotism and abuse,
Righteous wrath in us produce;
From them preserve us.
This the law that takes priority:
"Greater Good of the Majority";
On this, base our strength.

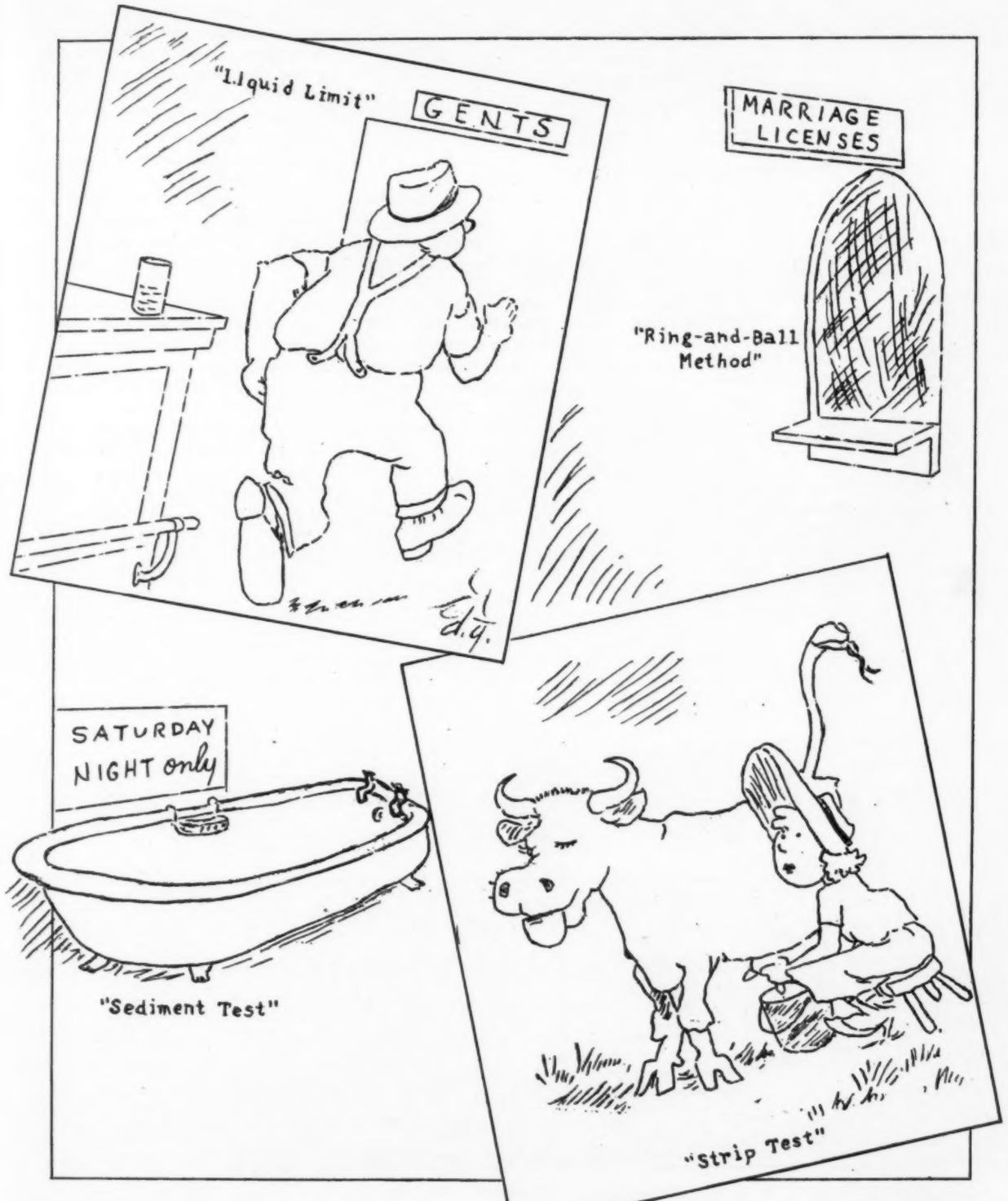
After havoc and disorder,
Help us build a new World Order;
Yet not by violence.
True Democracy shall rise,
Gradually, by compromise
To Economic Justice.

Grant that Freedom of the Press,
Of Assembly, Speech and Worship,
Keep Democracy in action.
God of Thunder, Lord of Light,
Lead us under banner bright,
FORWARD AND UPWARD!

Victor Uribe Troncoso

• •

¶ I have just tried out a special solder developed for the soldering of all hard-to-solder metals such as aluminum, aluminum alloys, die cast, Dowmetal, Almico, cast iron, etc. The material, perfected by the Lloyd S. Johnson Company, 2241 Indiana Avenue, Chicago, Illinois, is exceptionally free-flowing and provides unusual tensile strength in sheet metals and extruded aluminum. It retains color of aluminum and Dowmetal, and is corrosion resistant. Solder comes conveniently rolled ⅛ in. square and runs approximately 270 inches to the pound.



LABORATORY TESTS

¶ A. P. J. is indebted to the Montana Centerline for the above cartoon. Can anyone beat these?

¶ Adios, Amigos Mios! With this installment of Observations, A. Puddle Jumper dug his uniform out of the moth balls; and by the time you read this will be doing his bit with the Air Service Command of the Army Air Forces. I hope you will continue sending your contributions to ROADS AND STREETS. The next big puddle I have to jump will be on my way to Tokyo. So, until this fracas is over, I bid you farewell.

V. J. (Vic) Brown
Major, C.A.C.

• •

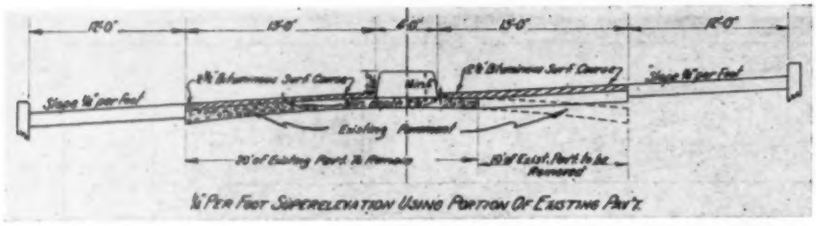


Fig. 22

(*Continued from page* 47)

forced concrete divisor 2 feet wide was doweled to the existing concrete pavement. The condition of the existing concrete necessitated a 2-inch bituminous surface course which was also placed over the napped stone base, providing 23 feet of pavement each side of the 2-foot divisor. This work was sponsored by the state as a W.P.A. project.

(5) The typical section, figure 21, shows a four-lane divided dual type pavement on one of Pennsylvania's heavily traveled highways in the City of Pittsburgh. The existing 30-foot concrete pavement was used for the base course of the two interior lanes each 13 feet wide.

This dual type pavement is one of the very few built by the Department since 1939. The location of the project made it possible to secure a dense bituminous concrete for the interior lanes. Figure 22 shows the method used to provide superelevation on the 2-degree and 4-degree curves. The crown of the existing pavement had not been removed nor had any superelevation been provided. It was necessary to remove the outside 10-foot lane of the original 30-foot pavement to provide adequate superelevation of ¼-inch and ⅜-inch on these curves.

(6) A cross section of a recently constructed four-lane divided highway is shown by figure 23. The paved median strip of cold-laid plant-mixed bituminous concrete on an 8-inch flexible base has an effective width of 5 feet.

The detail shows special integral curbing adjacent to the median strip.

(7) Figure 24 shows a layout of a section of U. S. Route 422, Berks County, now under contract. The white line shows the existing 20-foot reinforced concrete pavement used as a one-directional road for east-bound traffic. The black line to the north represents the new 24-foot reinforced concrete pavement used as a one-directional road for west-bound traffic. At each end these directional roads converge and are separated by a concrete raised divisor 2 feet in width. The spur was constructed to provide a connection for west-bound traffic with Route 318. The existing 20-foot reinforced concrete pavement was built in 1930 and has a fair salvage value. The alignment and grades on the original concrete pavement are not entirely satisfactory. Minor adjustments of any appreciable benefit would result in excessive damages due to adjacent real estate development. Under these circumstances the department obtained at this time on the south side of the newly constructed one-directional road sufficient right-of-way to construct another 24-foot pavement, parallel to the new west-bound pavement. This additional pavement will not be constructed until the existing 20-foot concrete pavement becomes unfit for thru-east-bound traffic.

(*Continued on page* 53)

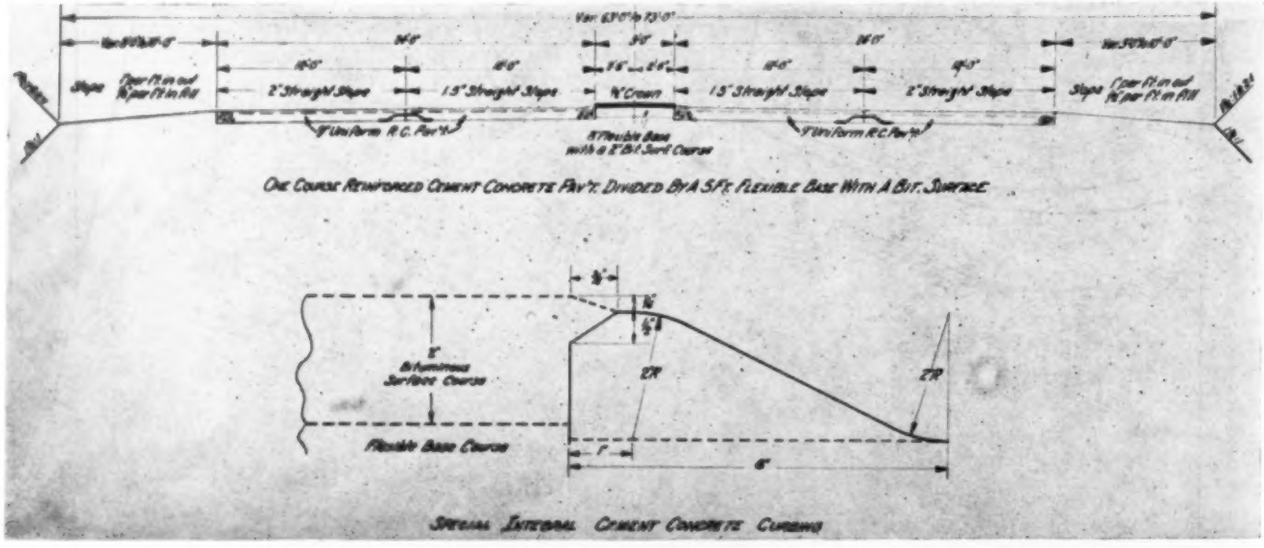

Var. 63'-0" to 73'-0"
16'-0"
14'-0"
12'-0"
2" Straight Slope
15" Straight Slope
4" Crown
9" Uniform R.C. Pav't.
8" Flexible Base with a 2" Bit. Surf. Course
One Course Reinforced Cement Concrete Pav't. Divided By A 5 Ft. Flexible Base With A Bit. Surface
2" Bituminous Surface Course
Flexible Base Course
2'R
Special Integral Cement Concrete Curbing

Fig. 23

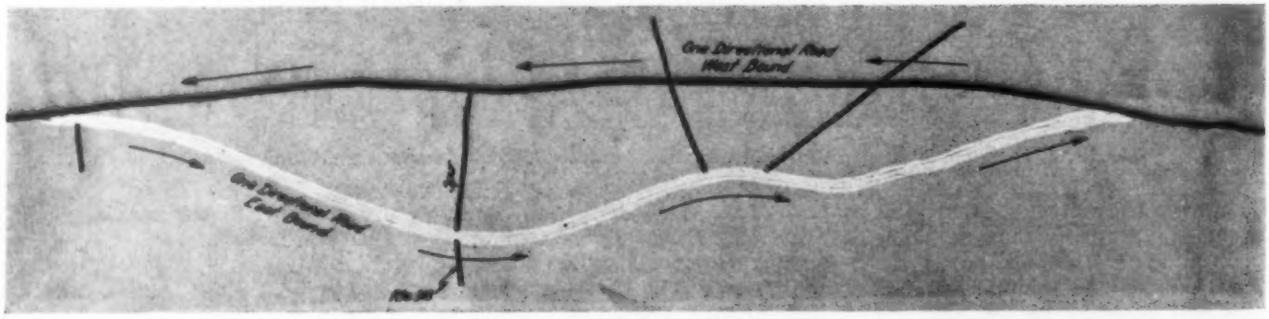
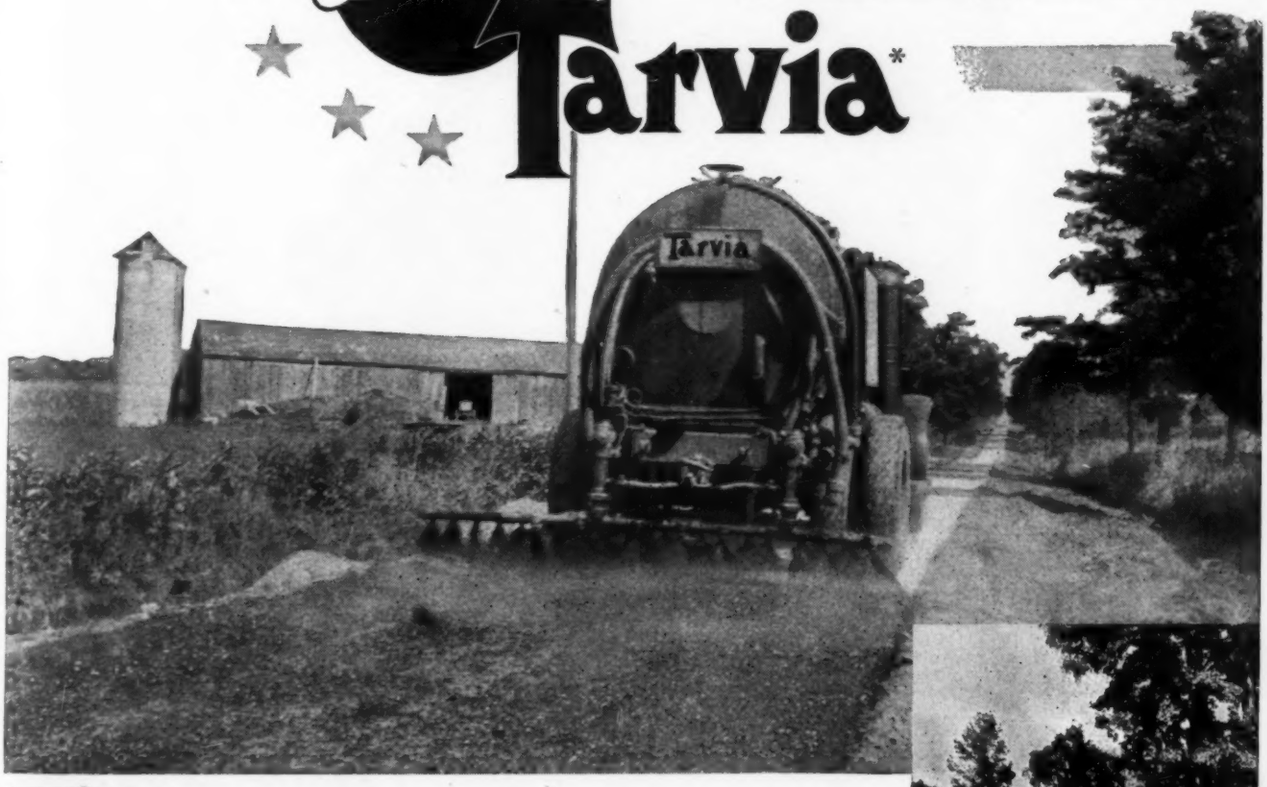


Fig. 24

Barrett Tarvia*



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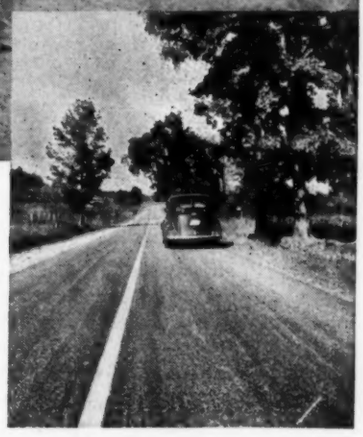

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(*Continued from page* 50)

The typical section, figure 25, is beyond the limits of the one-directional roads and shows the design used where none of the existing pavement could be salvaged.

The view in figure 26 shows the completed reconstructed pavement with raised concrete divisor. Thru this section the contractor used bituminous curing on the new pavement which is dark. The existing pavement which was salvaged is lighter. Specifications did not permit bituminous curing of the raised concrete divisor placed on either the existing or new concrete pavement.

We have many miles of State highways which are not adequate for the present traffic. Through necessity we must continue our present policy and salvage the maximum amount of the original investment.

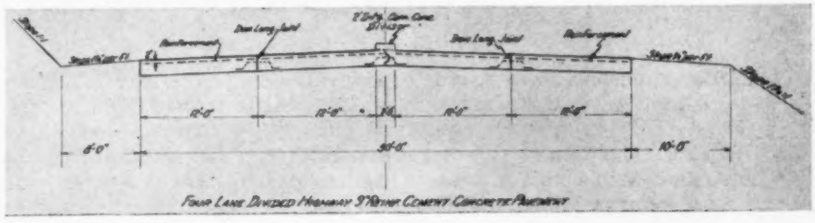


Fig. 25

Fig. 26

Cost of Center-Striping in West Virginia

Center-striping of state highways in West Virginia in 1941 cost $62,642, according to the report of E. L. Worthington, Maintenance Engineer, State Road Commission. More than 42,000 gal. of paint were used.

The new center-line stripes were placed principally on the State's primary road system of 4,738 miles and consisted of 2,828 miles of solid single line, 1,290 miles of broken single line and 1,044 of double-lines, placed on curves and obstructed vision points to prohibit passing.

Labor cost for the center line striping was $14,064 and equipment costs amounted to $6,025. Paint used in the work cost $42,198.45, averaging 99 ct. per gallon. An average cost per mile of all types of center line stripe was $12.13.

The Commission uses a transit to locate the line on all long tangents and tape measurements to locate the line on all curves. The broken single line is painted 4 in. wide on alternate 50-ft. sections. The solid single line is 4 in. wide, painted continuous and the solid double line includes two 4-in. stripes painted continuous with a 4-in. space between.

Average cost of the solid single line stripe was $10 per mile. The cost of broken single line average $6.60 per mile and the solid double line averaged $16.80 per mile.

▼

Lightweight Concrete Mixing Materials.—The development, method of manufacture, properties, uses and economic status of the more common lightweight materials for making concrete are discussed in detail in Bureau of Mines Information Circular No. 7195, by Forrest T. Moyer, Associate Mineral Economist, copies of which may be obtained by writing to the Bureau of Mines, Department of the Interior, Washington, D. C.

New Developments In Highway Maintenance

By **R. H. STEKETEE**
Maintenance Engineer, Wayne County Michigan Road Commission

Abstract of a paper presented at the 28th Annual Highway Conference at the University of Michigan, Feb. 18, 1942

HIGHWAY officials have found it necessary to give much more study to maintenance work. Organizations have been changed so that each detail of work can be more economically handled. The fullest use of available equipment is obtained by careful planning. Use of the right material for a particular job rather than a readily available substitute gives more lasting results and proves an economy.

I will discuss each phase of maintenance and highway service separately, emphasizing the things which might be considered new developments in the work.

Grade and Drainage

Maintenance of the grade and providing adequate drainage for a road is, as it always has been, the first fundamental that must be considered to provide a suitable road surface. Modern traffic requires wider grades. On new jobs this becomes a construction item but on the many miles of roads not under construction this work becomes maintenance. Many short sections of roads require widening in order to make them safe for the public. This type of work can usually be fitted into a maintenance program by careful planning. It provides a suitable job for crews at such time as they cannot do certain other parts of the work because of weather conditions.

The improvement of drainage along a road also falls in the class of necessary betterments that must be provided under maintenance.

Probably the most important step forward in the maintenance of grades and drainage is the application of "Soil Mechanics" to this phase of the work. Much money and time can be saved if the principle of soil mechanics is applied to the "mudholes" which repeatedly appear on many of our roads. A soil study at the places where these "mudholes" occur will tell what treatment is necessary to prevent them from continuously reoccurring. Often the cure is simpler and less costly than the old method of pouring in expensive surfacing material. Every maintenance organization should have access to "soil analyses" to assist them in grade and drainage maintenance.

Structures

Much of what has been said about grade and drainage maintenance applies equally as well to structures built into the highway. Many culverts and small bridges were originally constructed when loads on the highways were much lighter and slower moving, and when the ditches that flow through them were not carrying the rapid run-off caused by the increased development of the surrounding territory. The work of inspecting these culverts and bridges and reinforcing them is usually considered a maintenance problem. Often it is necessary to widen the roadway across them to provide safety not only for vehicular traffic but in many built-up communities for school children and other pedestrians using the highway.

Guardrails on culvert and bridge approaches, on curves, embankments, along deep ditches and at many intersections are necessary to provide warning of danger and protection from it. The maintenance and installation of guardrail is important for both safety and appearance. The various types—plank, cable and the steel ribbons and rails—all have their maintenance problems.

Road Surfaces

The surface of a road is the measuring stick which the public uses to determine the kind of service received from their road system. Whether the surface is of brick, concrete, any of the various types of bituminous mixes, macadam, gravel, cinders or natural soil, it is necessary to plan maintenance operations so that the most and best service can be secured from the road. All of our roads from industrial streets in cities to sand trails in the north woods are important links in our present-day highway system, and the surface of them must be kept in good condition.

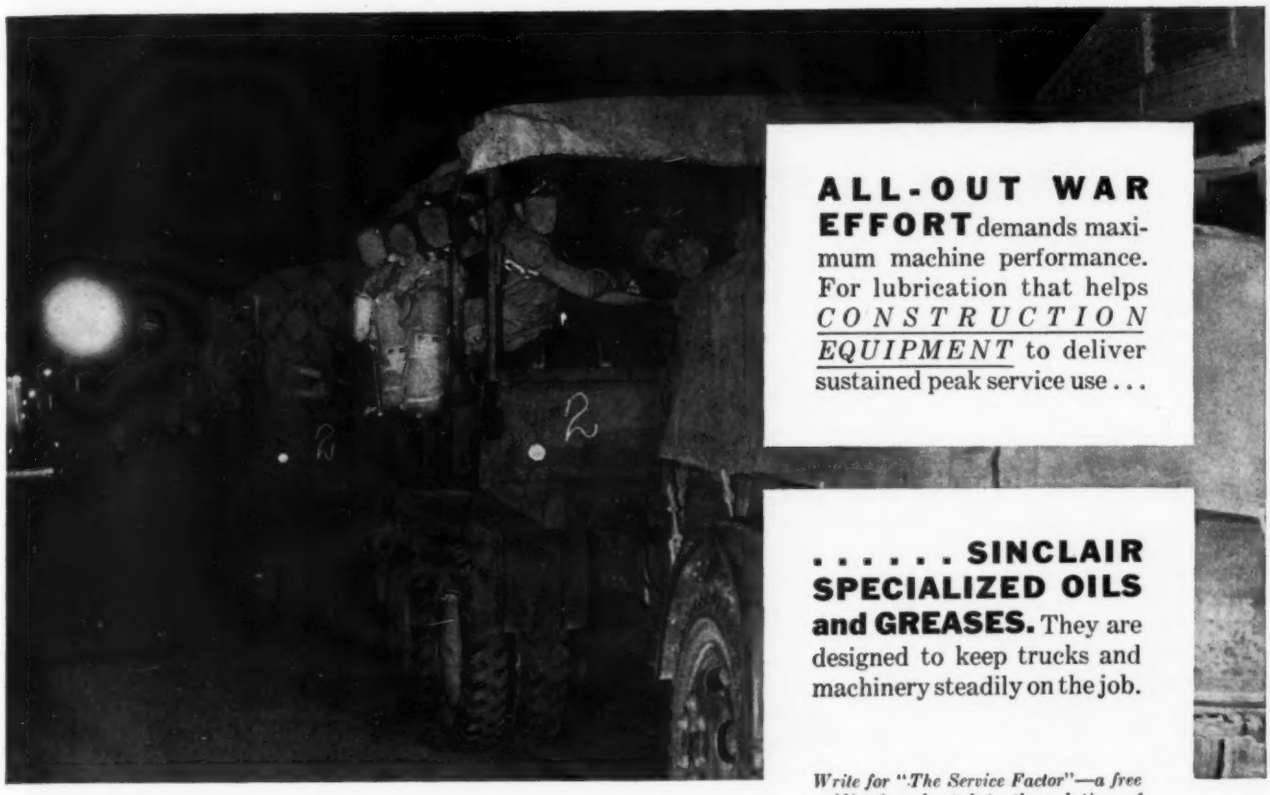
Problems occuring in the maintenance of rigid type pavements are quite familiar to most of us. Cracks and joints in the surface must be kept sealed. Bituminous materials have been used for this purpose for years. Recently, however, improvement has been made in materials available for that purpose, and also in the placing of the material into the cracks and joints. Use of compressed air for cleaning openings has made it possible to get results that are much more permanent than by the old sweeping method. The penetration is greater as well as the adhesion to the sides of the cracks.

A crack pouring machine is now on the market which will probably eliminate the "bucket brigade" now in common use. This outfit, by means of a heating torch and shoe, heats the crack and delivers the bituminous material into it at the right temperature. The problem now is to supply the material to this pouring pot. We hope to develop a method for this which should greatly reduce the labor for such maintenance and the results should be much more lasting.

Patching pavement surfaces is always a major problem. First consideration in repairing a break in the surface should be given to the interference with the use of the road because of the operations. The day of "Road Closed for Repairs" signs is largely past. In fact it is not good business to even close half of the road unless traffic cannot be handled in any other way. It seems to be quite a general practice now to provide "run-arounds" on the shoulder of the road. The use of flagmen to control traffic when it is necessary to limit traffic in a single lane is essential to safety.

The use of bituminous mixes for surface patching of pavements has

(*Continued on page* 67)



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Studies of Soil–Aggregate Base Course Mixtures

By **J. B. GARNEAU, F.C.I.C. and C. E. BELAND, F.C.I.C.**

Respectively, Chief Chemist and Asst.-Chief Chemist, Quebec Highways Department

A CO-OPERATIVE program of research in base course stabilization was undertaken during the winter of 1939-1940 under the direction of Dr. N. W. McLeod, a well-known Canadian soil scientist, and participated in by the Queen's University, Kingston, the Ontario Highway Department, L'Ecole Polytechnique, Montreal, the Imperial Oil Research Laboratories, Sarnia, and our Quebec Highways Laboratory.

Our part of this investigational work has been to determine by means of compression and capillary water absorption tests the effects of variable gradation, moisture content and admixtures upon the strength and stability of soil-aggregate base course mixtures.

In the experiments carried out for that purpose, aggregates of various sizes and a 22 PI clay were mixed together in such proportions as to meet nine different gradations within the grading band of the Calcium Chloride Association chart and as to give the final mix a constant plasticity index of 7. The admixtures compared were representative examples of the four types of stabilization, i.e., mechanical, chemical, cementation and waterproofing; they comprised *water-soluble* products, such as calcium and sodium chlorides, waste sulphite liquor, and *water-insoluble* binders, such as portland cement, light asphalts and tars. The details of the whole research work performed and the interpretation of the results obtained appear in the following publications: ROADS AND STREETS, Volume 84, No. 3, March, 1941; *Engineering and Contract Record*, Volume 54, No. 6, February 5, 1941; *Roads and Bridges*, Volume 79, No. 8, August, 1941, Proceedings of the 25th Annual Convention of the Canadian Good Roads Association, 1940, and *Bulletin des Extraits de Revues Routières*, No. 44, January, 1941.

Waterproofing Against Capillary Action

The definite information now at hand as to the extent and the rate of drop in compressive strength of soil-aggregates as their moisture content increases enables one to conclude it is highly desirable, from the stability standpoint, that the base course be so constructed as not to be affected by the action of capillary water. This beneficient result may be insured by (a) laying it on a porous soil; (b) keeping the ground water level at a minimum of four feet from the top of the subgrade and compacting its top foot to maximum density; (c) protecting the base course from subgrade moisture by means of a bituminous primer; (d) integrally waterproofing the mechanically-stabilized base course mixtures.

TABLE I

Grading	Description	Clay 22 PI Percent	Moisture Content	Compressive Strength lb./sq. in.	Total Absorption
No. 1	Ideal or medial	17	1.4	76.6	2.1
	Ideal or medial	17	2.4	72.5	4.6
No. 2	Medial to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	1.4	80.1	2.0
	Medial to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	2.4	69.6	4.6
No. 3	Medial to No. 10, then to limiting maximum of fines below No. 40 sieve	22	1.4	84.9	3.2
	Medial to No. 10, then to limiting maximum of fines below No. 40 sieve	22	2.5	73.3	5.1
No. 4	Limiting minimum of coarse to No. 10, then to medial grading of fines below No. 40 sieve	17	1.3	114.3	2.3
	Limiting minimum of coarse to No. 10, then to medial grading of fines below No. 40 sieve	17	2.9	71.9	4.9
No. 5	Limiting minimum of coarse to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	1.4	123.7	2.1
	Limiting minimum of coarse to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	3.2	69.0	3.9
No. 6	Limiting minimum of coarse to No. 10, then to limiting maximum of fines below No. 40 sieve	22	1.5	103.7	2.4
	Limiting minimum of coarse to No. 10, then to limiting maximum of fines below No. 40 sieve	22	2.9	79.5	4.9
No. 7	Limiting maximum of coarse to No. 10, then to medial grading of fines below No. 40 sieve	17	1.3	67.2	2.8
	Limiting maximum of coarse to No. 10, then to medial grading of fines below No. 40 sieve	17	2.9	56.5	4.4
No. 8	Limiting maximum of coarse to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	0.9	70.7	1.7
	Limiting maximum of coarse to No. 10, then to limiting minimum of fines below No. 40 sieve	11.5	2.8	38.9	4.2
No. 9	Limiting maximum of coarse to No. 10, then to limiting maximum of fines below No. 40 sieve	17	1.5	74.3	2.3
	Limiting maximum of coarse to No. 10, then to limiting maximum of fines below No. 40 sieve	17	3.1	70.7	4.7

CORRECT TIMING FOR SLAB FINISHING

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This integral waterproofing action is insured by bitumens only. As a matter of fact, it has been found in the first step of our investigations that *water-soluble* admixtures presented no advantages to base courses, except a slight lessening of the work of compaction due to a slowing down of the evaporation and a decrease in the freezing point of water absorbed while small amounts of *portland cement* improved the compressive strength without increasing the resistance to capillary water absorption. The waterproofing effect of light bitumens was, however, accompanied by a slight decrease in strength. Therefore, the two most promising base course admixtures for further investigation were bituminous materials (asphalts and tars) and portland cement.

Further Investigations

Our research program was continued during the winter of 1940-1941, using the same aggregates, gradings, plasticity index, preparation of test specimens and testing procedures as before. It was aimed at finding out by means of compression and capillary water absorption tests the effects on the strength of base course mixtures of the following variables:

(1) Grading of mechanically stabilized mixtures waterproofed with 1 percent bitumen and compacted to a density of 145 pounds per cubic foot.

(2) Grading of soil-aggregates, the maximum size of which is No. 4 sieve, waterproofed or not with 2 percent bitumen and compacted to a density of 136 pounds per cubic foot.

(3) Density of cement-stabilized mixtures waterproofed or not with 1 percent bitumen.

(4) Absence of various sieve sizes of the medial gradation of soil-aggregates waterproofed or not with 1 percent bitumen and compacted to a density of 145 pounds per cubic foot.

Presentation of Assembled Data

The test data accumulated in this investigation have been summarized in tabular form as an aid to interpreting and correlating them and drawing conclusions.

The effect of variable gradation on compressive strength and capillary water absorption of soil-aggregate mixtures waterproofed with 1 percent RC-1 asphalt is shown in table I.

We may draw from the aforegoing data that, other factors being equal, 1 percent RC-1 asphalt admixed with soil-aggregates *decreases* the compressive strength and capillary water absorption of the control mix. At a

TABLE II

		GRADINGS IN PERCENT				
		No. 1	No. 2	No. 3	No. 4	No. 5
Pass. No. 4	Ret. on No. 10	22.0	23.0	21.3	10.0	10.0
Pass. No. 10	Ret. on No. 40	30.9	41.3	13.9	38.8	54.3
Pass. No. 40	Ret. on No. 100	11.9	12.6	19.9	17.5	12.6
Pass. No. 100	Ret. on No. 200	8.7	5.3	10.6	7.7	5.3
Pass. No. 200		26.5	17.8	34.3	26.0	17.8

TABLE II—Continued

		GRADINGS IN PERCENT			
		No. 6	No. 7	No. 8	No. 9
Pass. No. 4	Ret. on No. 10	10.0	42.0	42.0	42.0
Pass. No. 10	Ret. on No. 40	25.1	8.4	25.7	7.4
Pass. No. 40	Ret. on No. 100	20.6	15.6	8.8	5.7
Pass. No. 100	Ret. on No. 200	10.2	7.8	5.9	12.3
Pass. No. 200		34.1	26.2	17.6	32.6

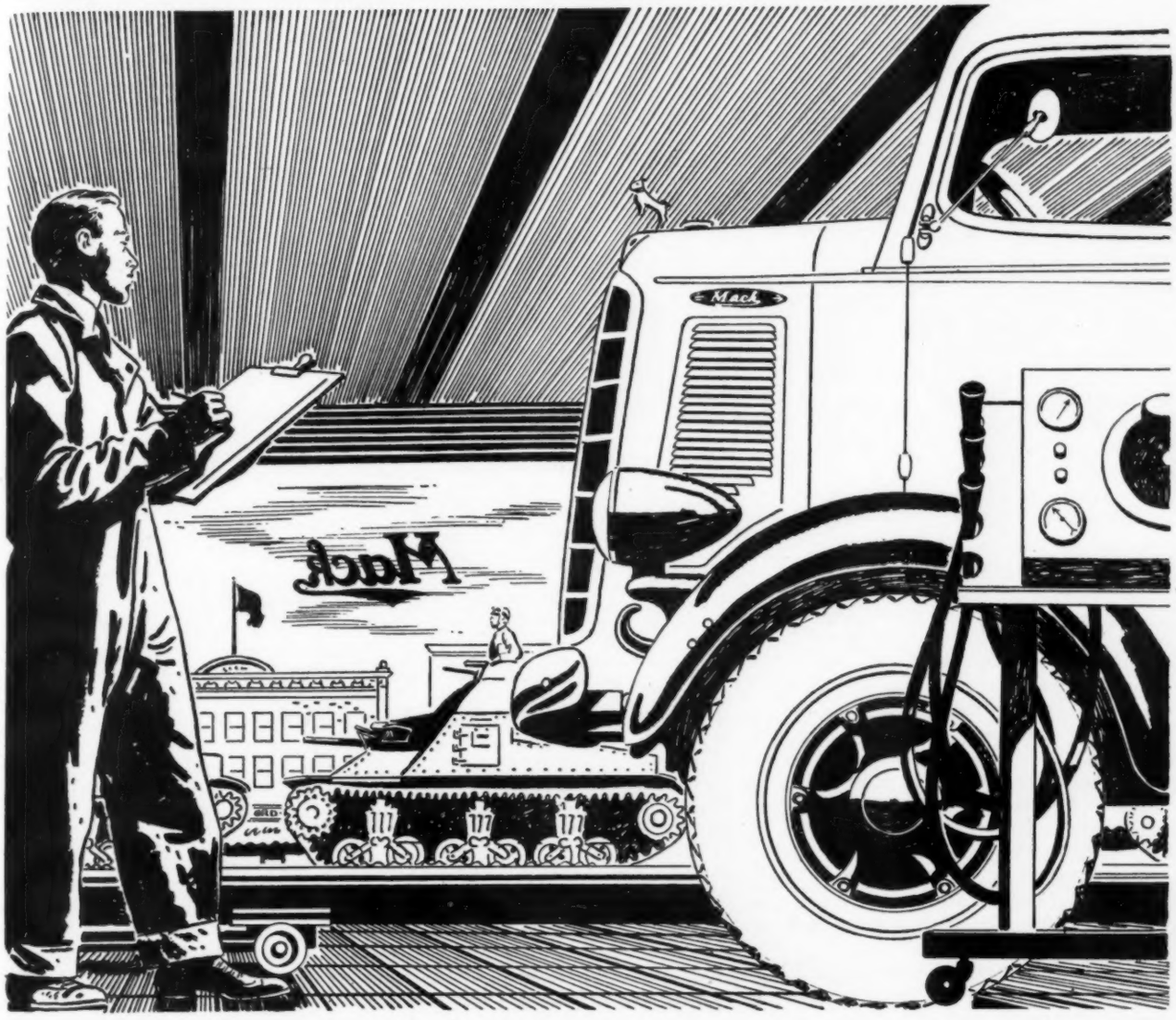
TABLE III

Grading	Admixture Percent	Admixture Kind	Moisture Content	Compressive Strength lb./sq. in.	Total Capillary Water Absorption Percent
No. 1		None	3.6	125.0	8.65
	2	RC-1	3.0	73.4	5.25
	2	RT-2	3.5	67.4	8.25
No. 2		None	3.6	116.1	7.75
	2	RC-1	2.8	80.2	4.55
	2	RT-2	3.3	53.0	7.20
No. 3		None	3.4	155.0	8.75
	2	RC-1	3.1	115.7	6.25
	2	RT-2	3.2	142.0	8.50
	2	RT-3	3.5	83.3	7.60
	2	RT-4	3.2	87.8	7.90
No. 4		None	3.1	142.1	8.15
	2	RC-1	2.7	82.3	5.00
	2	RT-2	3.2	78.4	7.20
No. 5		None	3.1	127.3	8.90
	2	RC-1	2.5	95.5	4.70
	2	RT-2	2.6	50.6	7.00
No. 6		None	3.5	140.9	8.10
	2	RC-1	3.1	124.9	5.90
	2	RT-2	3.7	87.2	7.95
	2	RT-3	3.4	99.6	7.60
	2	RT-4	3.4	89.6	7.80
No. 7		None	2.9	121.4	8.30
	2	RC-1	2.5	77.2	5.10
	2	RT-2	3.6	70.3	7.80
No. 8		None	3.0	102.6	8.40
	2	RC-1	2.8	64.9	4.45
	2	RT-2	2.6	50.6	7.00
No. 9		None	3.3	127.9	8.85
	2	RC-1	2.6	93.0	6.25
	2	RT-2	3.4	96.1	7.75

TABLE IV

Grading	Admixtures Percent	Admixtures Kind	Density lb./cu. ft.	Moisture Content	Compressive Strength lb./sq. in.	Total Capillary Water Absorption Percent
No. 4	1	cement	130	2.95	90.8	8.2
	2	cement	130	3.60	169.7	8.10
	4	cement	130	2.68	444.8	9.40
No. 4	1	cement	135	3.25	178.3	7.70
	2	cement	135	3.52	200.7	7.60
	4	cement	135	2.55	705.1	8.20
No. 4	1	cement	140	3.70	185.7	6.90
	2	cement	140	3.18	382.0	7.20
	4	cement	140	2.62	840.0	7.70
No. 4	1	cement	145	3.04	258.2	6.50
	2	cement	145	3.06	478.8	6.30
	4	cement	145	2.62	1184.5	6.70
No. 1	1	cement + 1% RC-1	135	0	285.4	4.15
	2	cement + 1% RC-1	135	0	474.0	4.00
	4	cement + 1% RC-1	135	0	536.5	3.05
	1	cement + 1% RC-1	135	3.60	110.7	4.70
	2	cement + 1% RC-1	135	2.60	263.4	5.35
	4	cement + 1% RC-1	135	2.20	466.2	4.55
No. 1	1	cement + 1% RC-1	145	0	447.5	4.15
	2	cement + 1% RC-1	145	0	652.1	3.05
	4	cement + 1% RC-1	145	0	1202.3	1.95
No. 1	1	cement + 1% RC-1	145	3.20	175.1	4.05
	2	cement + 1% RC-1	145	2.80	250.3	3.95
	4	cement + 1% RC-1	145	2.70	411.2	3.65
No. 1	1	cement + 1% RT-3	145	2.40	162.1	5.35
No. 5	1	cement + 1% RT-3	145	2.30	263.3	5.10
No. 6	1	cement + 1% RT-3	145	2.60	254.0	5.60

Every hour of lay-up time saved brings Victory a little closer . . .



A Message to Mack Owners on Truck Maintenance

It's going to be increasingly difficult to replace trucks during the critical days that lie ahead.

You who own Mack trucks have the advantage of the extra durability that's built into them. (That Macks *do* last longer is proved by figures which show that 7 out of every 10 Macks bought ten years ago are still in profitable use. *R. L. Polk survey, as published in Automotive News.*) But you can't hope to get the most out of your Macks unless you have them serviced promptly—regularly—at the nearest Mack factory branch or Mack dealer.

Consult your local Mack service manager for helpful, constructive advice on how best to conserve your truck equipment. Ask him about the Mack "Preventive Maintenance Plan," a practical system of periodic inspection and adjustment, which will save you money on repair bills—keep your trucks on the road for extra thousands of miles.

Remember, a truck is something more than a private investment in time of war. As a part of our vital transportation system, it is a public responsibility. Let us help you "keep 'em rolling."

MACK TRUCKS, INC., LONG ISLAND CITY, N. Y.

THE MOST COMPLETE LINE OF TRUCKS IN THE WORLD—
1 TO 45 TONS AND ALL HEAVY DUTY!

Mack

low moisture content (1 to 1.5 percent), the grading No. 5 shows the highest compression test result, whilst, at about 3 percent moisture content, the grading No. 8 gives the lowest strength. Doubling the moisture content of the specimens has the effect of almost doubling the total capillary water absorption.

To study the influence of gradation of soil-aggregates deprived of coarse particles retained on No. 4 sieve, waterproofed or not with 2 percent bitumen and compacted to a density of 136 pounds per cubic foot on their compressive strength and capillary water absorption, they were so arranged as to meet the nine following gradings, table II, within the band of the Calcium Chloride Association chart. The description of each one of the grading numbers appears in table I.

The results of the compression and capillary water absorption tests carried on soil-aggregates meeting the above grading requirements are given in table III.

The above figures show clearly that the grading No. 3 gives the highest compressive strength to these soil-aggregate mixtures. Their high capillary water absorption is easily explained by the low density (136 lb. per cu. ft.) and the high percentage of voids. The bituminous materials decrease the compressive strength and cut the capillary water absorption only slightly at the rate used.

The influence of density on portland cement stabilized soil-agregates, waterproofed or not with 1 percent bitumen, is shown in table IV.

It is obvious that the strength of cement stabilized soil-aggregates increases with the density to which they are compacted and the percentage of portland cement incorporated. From the standpoints of compressive strength and capillary water absorption, it is preferable to get a higher density than to double the amount of cement. Bituminous materials improve the resistance to capillary water absorption, although, at equal moisture content, they reduce the high compressive strength of cement stabilized mixtures to a certain extent.

The effect of the absence of various sieve sizes of the medial gradation on the compressive strength and capillary water absorption of soil-aggregate base course mixtures, waterproofed or not with 1 percent RC-1 asphalt and compacted to a density of 145 pounds per cubic foot, has also been investigated. The various gradings obtained are given in table V.
V.

TABLE V

MEDIAL GRADATION—GRADINGS IN PERCENT

	10 to 40 sieve size absent, distributed over other coarse sizes. Clay 22 PI, 15 percent No. 10	10 to 40 sieve size absent, distributed over all other sizes. Clay 22 PI, 11 percent No. 11	40-100 sieve sizes absent, distributed over all other fines. Clay 22 PI, 9 percent No. 12	40-200 sieve sizes absent, replaced by equiv. minus 200 sand. Clay 22 PI, 9 percent No. 13	Minus 200 sand sieve size absent, replaced by equiv. 40-100. Clay 22 PI, 9 percent No. 14	Minus 200 sand sieve size absent, replaced by equiv. 40-100 and 100-200. Clay 22 PI, 9 percent No. 15
Pass. 1 in. Ret. on ¾ in. ..	25.7	23.8	20.3	20.3	20.3	20.3
Pass. ¾ in. Ret. on ½ in. ..	23.1	21.5	18.2	18.2	18.2	18.2
Pass. ½ in. Ret. on No. 4 ..	7.9	7.4	6.3	6.3	6.3	6.3
Pass. No. 4 Ret. on No. 10 ..	15.3	13.3	11.2	11.2	11.2	11.2
Pass. No. 10 Ret. on No. 40 ..	0.9	1.1	16.0	16.0	17.5	17.3
Pass. No. 40 Ret. on No. 100..	8.4	10.7	1.3		13.5	11.7
Pass. No. 100 Ret. on No. 200..	2.3	5.1	7.7	0.5	4.5	6.5
Pass. No. 200.....	16.4	17.1	19.0	27.5	8.5	8.5

TABLE VI

Sieve Size Absent	Distributed Over	Admixture	Moisture Content, Percent	Compressive Strength lb./sq. in.	Total Capillary Water Absorption, Percent
10-40	Other coarse sizes	None	0.0	120.8	5.90
10-40	Other coarse sizes	None	2.2	84.9	6.25
10-40	Other coarse sizes	1% RC-1	2.8	49.4	4.75
10-40	Other sizes	None	0.0	225.6	6.30
10-40	Other sizes	1% RC-1	0.0	145.0	2.95
10-40	Other sizes	None	1.9	91.4	8.35
10-40	Other sizes	1% RC-1	2.6	34.1	4.25
40-100	Other fine sizes	None	0.0	285.3	6.25
40-100	Other fine sizes	1% RC-1	0.0	192.8	3.50
40-100	Other fine sizes	None	2.2	107.9	7.20
40-200	Minus 200 sand	None	0.0	248.2	6.70
40-200	Minus 200 sand	1% RC-1	0.0	246.4	4.35
40-200	Minus 200 sand	None	2.4	168.0	7.95
40-200	Minus 200 sand	1% RC-1	2.0	82.5	5.45
Minus 200 Sand	40-100 size	None	0.0	313.7	5.65
Minus 200 Sand	40-100 size	1% RC-1	0.0	205.1	1.75
Minus 200 Sand	40-100 size	None	1.8	114.4	6.15
Minus 200 Sand	40-100 size	1% RC-1	2.7	33.6	3.60
Minus 200 Sand	40-100 and 100-200 sizes	None	0.0	285.4	6.30
Minus 200 Sand	40-100 and 100-200 sizes	1% RC-1	0.0	201.6	2.55
Minus 200 Sand	40-100 and 100-200 sizes	None	2.1	86.7	6.00
Minus 200 Sand	40-100 and 100-200 sizes	1% RC-1	1.6	51.9	3.90

The results of this investigation are summarized in table VI.

The above figures once more corroborate the statement already made that other factors being equal, light bituminous admixtures decrease the compressive strength to a certain extent and lower the capillary water absorption. It may be seen also that for equal mixture content, the distribution of the 10-40 fraction over other coarse sizes is the most harmful to the strength, whilst the replacement of the 40-200 fraction by the equivalent minus 200 sand seems advantageous from the same viewpoint. This result may be partly explained by the drier mixes obtained by distributing the coarse sieve sizes absent over the fine ones.

General Conclusions

(1) Other things being equal, the waterproofing action produced by small amounts of light bituminous materials admixed with soil-aggregate base coarse mixtures is always accompanied with some decrease in compressive strength.

(2) This waterproofing effect is more efficient when the density of soil-aggregate mixtures is greater and their initial moisture content lower.

(3) Other things being equal, the strength of cement-stabilized soil-aggregates increases as their density and the percentage of portland cement are higher. From both strength and resistance to capillary absorption standpoints, it is generally more profitable and economical to increase the

density than to double the amount of portland cement (varying from 1 to 4 percent).

(4) A combination of portland cement (1 to 4 percent) with 1 percent light bitumen (such as RC-1 asphalt) improves to a great extent both the strength and resistance to capillary water absorption of mechanically stabilized mixtures with which these two different stabilizers are incorporated.

(5) Other things being equal, the gradation of base course mixtures, deprived of particles coarser than No. 4 sieve, that gives the highest compressive strength is the one corresponding to medial coarse to No. 10, then to limiting maximum of fines below No. 40 sieve.

(6) For equal moisture content, the absence of a coarse size fraction of the medial grading distributed over one or several finer sieve sizes has apparently a beneficient effect on the strength of soil-aggregates for base course. This result may be partly due to the dried specimens thus obtained.

Bureau of Construction of WPB Moved to New York

The Bureau of Construction, recently established to coordinate all construction functions of the War Production Board, has moved to New York and opened headquarters in the Empire State Building.

Except for a small office staff which will remain in Washington for laison work, the entire organization under William V. Kahler, chief of the Bureau, is affected by the change. Thomas L. Peyton, assistant to the Chief, will be in charge of the Washington office.

The Bureau is divided into five operating branches:

Project Analysis Branch
Materials Control Branch
Project Service Branch
Housing Branch
Consultation Branch

The Project Analysis Branch handles all applications for private construction and recommends priority rating for them. It administers limitation and conservation orders covering construction. Various agencies interested in construction have designated representatives to be stationed in New York to work with the Bureau in determining the essentiality and urgency of projects.

These include the Materials Division, Bureau of Industry Branches, Bureau of Priorities, Bureau of Governmental Requirements, the Army-Navy Munitions Board, the Plant Site Board, the Federal Works Administration, the Federal Housing Administration and the Federal Public Housing Authority.

The Materials Control Branch reviews the use of materials in projects which have been designated as essential by the Project Analysis Branch. The former Branch is guided by criteria established in the Bureau of Industrial Conservation, War Production Board, and applies these principles to insure a minimum use of critical materials.

It scrutinizes carefully all designs for construction and order, wherever possible, elimination, substitution and reduction of materials which can be put to use in the production of War material.

The Project Service Branch works closely with industry and with the Army, Navy Defense Plant Corporation and other Government agencies, rendering whatever service is needed to eliminate construction delays so that scheduled completion dates are met. It advises and assists these groups on design and construction matters including the procurement and expediting of needed materials.

The Housing Branch recommends priority ratings for

(Continued on page 84)

250 LINEAR FT. per HOUR of 25 FT. SLAB (MINUS 1" SLUMP 9"-6"-9" THICK)

with this JAEGER *Screw* SPREADER

and this JAEGER *Type "H"* FINISHER

Ferry & Pearson Laid Up to 135 Cu. Yds. an Hour, AVERAGED OVER 120 Cu. Yds. an Hour, Day after Day, on Muroc Bomber Range, California

Record-Breaking Production of Denser, Smoother Slab—Fewer Men

On U. S. airport, near Ft. Wayne, James A. McKay & Sons report Jaeger Spreader-Finisher team was absolutely necessary to handle the very dry concrete in 25' width.

On 86 miles of 20'-24' slab, Koss Constr. Co. used 4 Screw Spreaders, report all engineers highly pleased.

On Ford's Willow Run Bomber Plant, 4 Jaeger Finishers placed 63 miles of 20' slab in 42 days.

On Higley Airport, Jaeger Team placed 362' per hour of 1½" slump concrete 12'6" wide without labor in front of machines and no trace of segregation.

Saved 3 to 5 men behind 34E dual paver, reports C. H. Atkinson Paving Co., Missouri.

On Pennsylvania Turnpike Adam Eidemiller did 5160' in 14 hours, Tri-State Engr. averaged 4000 sq. yds. daily on 167,000 sq. yd. contract.

Spreader, equipped to both spread and finish, laid up to 150 tons hourly of bituminous resurfacing for Barber Construction Co., Chicago.

Ask Us for Contractors' Detailed Reports and Catalog

THE JAEGER MACHINE COMPANY

223 Dublin Avenue, Columbus, Ohio

Conserving Truck Equipment With Preventive Maintenance

WITH the greater part of America's truck production consigned to the armed forces, and with new trucks for civilian use scheduled for strict allocation, it becomes imperative that trucks now on the road be kept at their highest peak of efficiency and be made to last as long as possible.

Proper maintenance, and in particular, preventive maintenance, the "stitch in time" that corrects small troubles before they develop into larger ones, thus assumes even greater importance in the truck operations of every user whether large or small.

To large contractors or those states and counties with hundreds of trucks, the benefits of preventive maintenance have long been known. Such organizations often have considerable investment in special service tools and invariably give their truck equipment periodic checkups and adjustments. For other companies and small counties and cities operating smaller numbers of trucks and who have not been able to do such a thorough job preventive maintenance has often tended to be of a haphazard nature or to be non-existent. It is to these latter agencies that the following facts on preventive maintenance will be most applicable.

Maintenance Plan

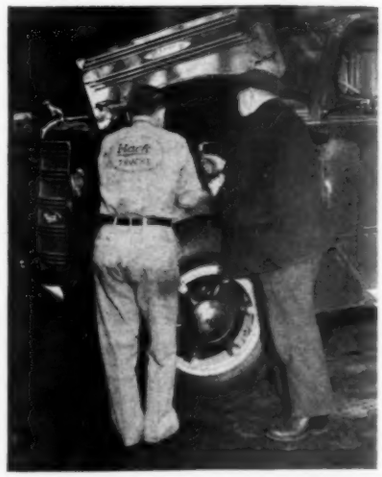
One of the most thorough and simplified systems of preventive maintenance that has come to our attention is that used by the Mack Company, manufacturers of Mack Trucks.

It is interesting to note that a system along the same lines has been adopted by the U. S. Army for efficient maintenance of the vast fleets of Army trucks now going into service.

This company's schedule of preventive maintenance incorporates an agreement whereby the owner brings his truck into the company's local branch shop at stated intervals at which time competent mechanics inspect, check, tighten, adjust and lubricate the chassis for a small nominal fee. After these check-ups, recommendations, if any, are made as to the need for minor repairs that should be attended to before they develop into something serious.

The inspection system used by the Mack Company can be applied to any make of truck and with the company's permission we are listing the necessary steps below for the benefit of any of our readers who may wish to adapt such a system to their own particular needs.

Mack preventive maintenance calls for periodic inspections at succeeding 1500-mile intervals, with special and more extensive adjustments at each succeeding 6,000 and 18,000-mile mark.



Mechanics working on truck

The 1500-mile Interval Service calls for the following:

EVERY 1500-MILE PERIOD

ROAD TEST—For running condition and report defects.
ENGINE—While warm inspect for fuel, oil and water leaks, and tighten.
CRANKCASE—Change engine oil.
OIL FILTER—Replace if bag-type.
OIL PRESSURE—Check and report.
AIR FILTER—Wash in kerosene and oil.
FAN BELT—Check and adjust as required.
DISTRIBUTOR — One turn grease cup using BRB grease (Ball and roller bearing grease).
GENERATOR—Add 8-10 drops light engine oil, or one turn grease cups with ball and roller bearing grease.
BATTERY — Check gravity. Add water. Clean and grease terminals.
CLUTCH—Adjust pedal free motion if necessary. Add BRB grease to release bearing if not prepacked. Add chassis-lubricating oil to yoke shaft.
TRANSMISSION—Add gear oil to level.
DRIVESHAFTS—Add gear oil to all open-type universal joints. Add short-fibre grease to slip spline. Add BRB grease to center bearing.
STEERING—Add gear oil to level of plug. Inspect drag link and drop arm, and add chassis lubricating oil. Inspect tie-rod, and add chassis lubricating oil. Add chassis lubricating oil to knuckles.
SHOCK ABSORBERS—Add chassis lubricating oil to links.
BRAKES—Add brake fluid to master cylinder to level.
REAR AXLE—Ad gear oil to level.
NOTE—Add any other items peculiar to your particular chassis.
REPORT any items requiring attention.

The above check-up is made at each succeeding 1500-mile interval. In addition, at the 6000-mile period the following schedule is performed:

EVERY 6000-MILE PERIOD

REPEAT 1500-mile period schedule.

Group of trucks being serviced

Excavations Are Its Meat!

"Eats right out of your hand for easy operation," says Francis Kluckhohn of Edw. H. Kluckhohn & Sons, Naperville, Ill., Contractor, of his Model 60 Clipper Trench Hoe.

Digging large trench and sewerage basins at army camps, airports and ordnance plants is not the only job at which Buckeye Clipper Trench Hoes excel — they're winning their spurs on scores of housing projects, excavating basements, large trench, drainage ditches and doing other dirt moving jobs at war-time speed.

Mevac metered vacuum power control puts the dipper through its paces fast and smooth. The strong tubular boom and stick can take it; and the operator can get out more yards per shift because he doesn't tire. There are no long levers to tug — just six small handles — yet operator has full "feel" of the work. It's got rhythm!

Besides vacuum control, Clippers have 23 other features preferred by most operators — independent chain crowd; tapered hook type rollers; no center pin to shear; automatic swing brake; simultaneous swing, hoist and travel; safety power drum brakes; solid comfort for operator and all the rest. It's tomorrow's trench hoe today!

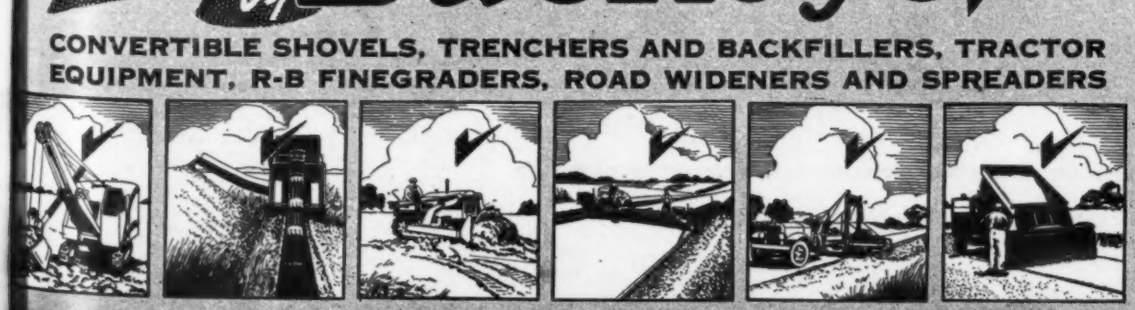
½ Yd. Capacity — 31″ x 36″ cut
¾ Yd. Capacity — 36″ x 41″ cut.

Both have 30′ digging radius and dig to 15′ deep. Gasoline or diesel. Quickly convertible to shovel, crane or pile driver.

Buckeye Traction Ditcher Co., Findlay, Ohio

Built by Buckeye

CONVERTIBLE SHOVELS, TRENCHERS AND BACKFILLERS, TRACTOR EQUIPMENT, R-B FINEGRADERS, ROAD WIDENERS AND SPREADERS



CHECK PAGE 6

IN ADDITION

CRANKCASE — Clean breather filter in gasoline, and oil.
OIL FILTER—Replace if can-type.
CYLINDERS — Tighten head stud nuts with tension wrench.
MANIFOLDS—Check and tighten nuts as required.
FUEL PUMP — Clean bowl (Renew diaphragm at 30,000 mile periods).
FAN BEARINGS—Add BRB grease.
DISTRIBUTOR — Adjust breaker points. Check and set advance if necessary. Check wiring and report condition.
SPARK PLUGS—Clean and set gap.
GENERATOR—Check and set charging rate as required. Clean and tighten terminals.
STARTING MOTOR — Add 8-10 drops light engine oil. Clean and tighten terminals.
DRIVESHAFTS—Tighten universal joint flange bolts. Check tightness of hubs on shafts, and report.
SPRINGS — Tighten clip nuts. Inspect leaves and center bolt and report.
BRAKES — Add 2-oz. special light oil (low-pour test) to vacuum power cylinder.
REAR AXLE—Tighten stud nuts holding differential to banjo. Tighten axle drive flange stud nuts.
REPORT—Any other item requiring attention.

After the above schedule the 1500-mile Interval Service is repeated until the next 6000-mile period and is then repeated again until the 18,000-mile period at which time the following schedule is fulfilled:

EVERY 18,000 MILE PERIOD

REPEAT 1500-mile period schedule and 6000-mile period schedule.

IN ADDITION

CRANKCASE — Remove pan, and clean pan and parts.
ENGINE—Inspect and tighten supports if necessary. Check and tighten bell housing screws as required.
VALVES—Check and adjust tappet clearance if necessary.
COMPRESSION — Check each cylinder and report.
CARBURETOR — Clean thoroughly and adjust as required. Check and adjust fuel level if necessary.
COOLING SYSTEM—Flush, and inspect hoses and report. Drain cylinder block as well.
DRIVESHAFTS—Check and tighten center bearing lock nuts and frame bolts.
STEERING—Check gear and take up excess back-lash, if any.
WHEELS—Check and set toe-in if required. Remove wheels, and clean bearings, Repack bearings with short-fibre wheel-bearing grease and adjust for proper end play.
BRAKES — Wash vacuum cylinder air cleaner in kerosene, and oil. Wash vacuum external valve air filter in gasoline, and oil.
REAR AXLE—Check end play in pinion bearing and report. Check for excess back lash and report.
REPORT any other items requiring attention.

After the above schedule has been performed the entire cycle repeats itself. It is claimed that in actual practice this "Preventive Maintenance Plan" has on numerous occasions proved itself as one of the surest ways of detecting minor troubles, which if left unattended would have resulted in breakdowns on the road with all the attendant expense and inconvenience.

Properly maintained, your present trucks will render many additional thousands of miles of uninterrupted service. Today it is not only good business to conserve your truck equipment through periodic inspection, but it is also good patriotism. For each in its own way, every truck on the road today is doing its bit in America's drive for ultimate victory.

Analysis of Skew Slabs

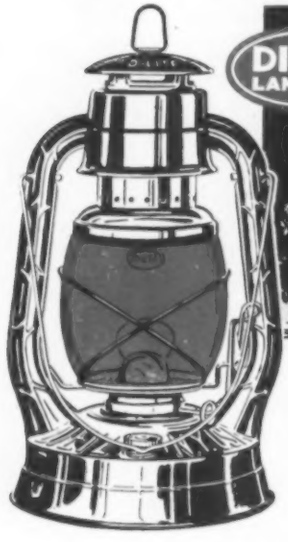
The modern highway, straightened to accommodate the greater speeds and more exacting safety requirements of present-day traffic, has required the design of increasing numbers of skew bridges. Despite this fact, relatively little is to be found in the literature regarding skew slabs. As a result of this lack of analytical data the design of skew slabs is at present based largely on empirical rules formulated by judgment, and influenced by comparisons with rectangular slabs which can be analyzed.

In Bulletin No. 332, "Analyses of Skew Slabs," by Vernon P. Jensen, which has just been issued by the Engineering Experiment Station of the University of Illinois, the behavior of skew slabs is determined by means of difference equations. The slabs studied have various angles of skew and various boundary conditions, and are loaded uniformly or by wheel loads. Particular study is made of a simple-span slab bridge with curbs.

In order to develop a procedure for analyzing a skew slab bridge with curbs, a study was made of various networks of points and the difference equations relating to these networks and to the various boundary conditions encountered. It was found that a square or rectangular network could be conveniently used for a number of angles of skew and proportions of sides, but that it was desirable also to develop equations applicable to a network of points formed by the intersections of lines parallel to the sides of the skew panel.

Such equations were developed, and applied first to a number of slabs under uniform loads. Calculations were made later for a slab bridge having a 26-ft. roadway, 45-deg. skew, 19 ft.-6 in.-span (normal to the abutments), ordinary curbs, and loading designated as H-20 by the American Association of State Highway Officials.

Until the supply available for free distribution is exhausted, copies of Bulletin No. 332 may be obtained without charge upon application to Engineering Experiment Station, Urbana, Ill.



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Place DIETZ LANTERNS on guard for every emergency use. They faithfully guide the way, night after night, without diminishment of light.

DIETZ LANTERNS will not fail or falter as long as a drop of oil remains to burn. Many models will give light and safety for an entire weekend with plenty of kerosene left to spare.

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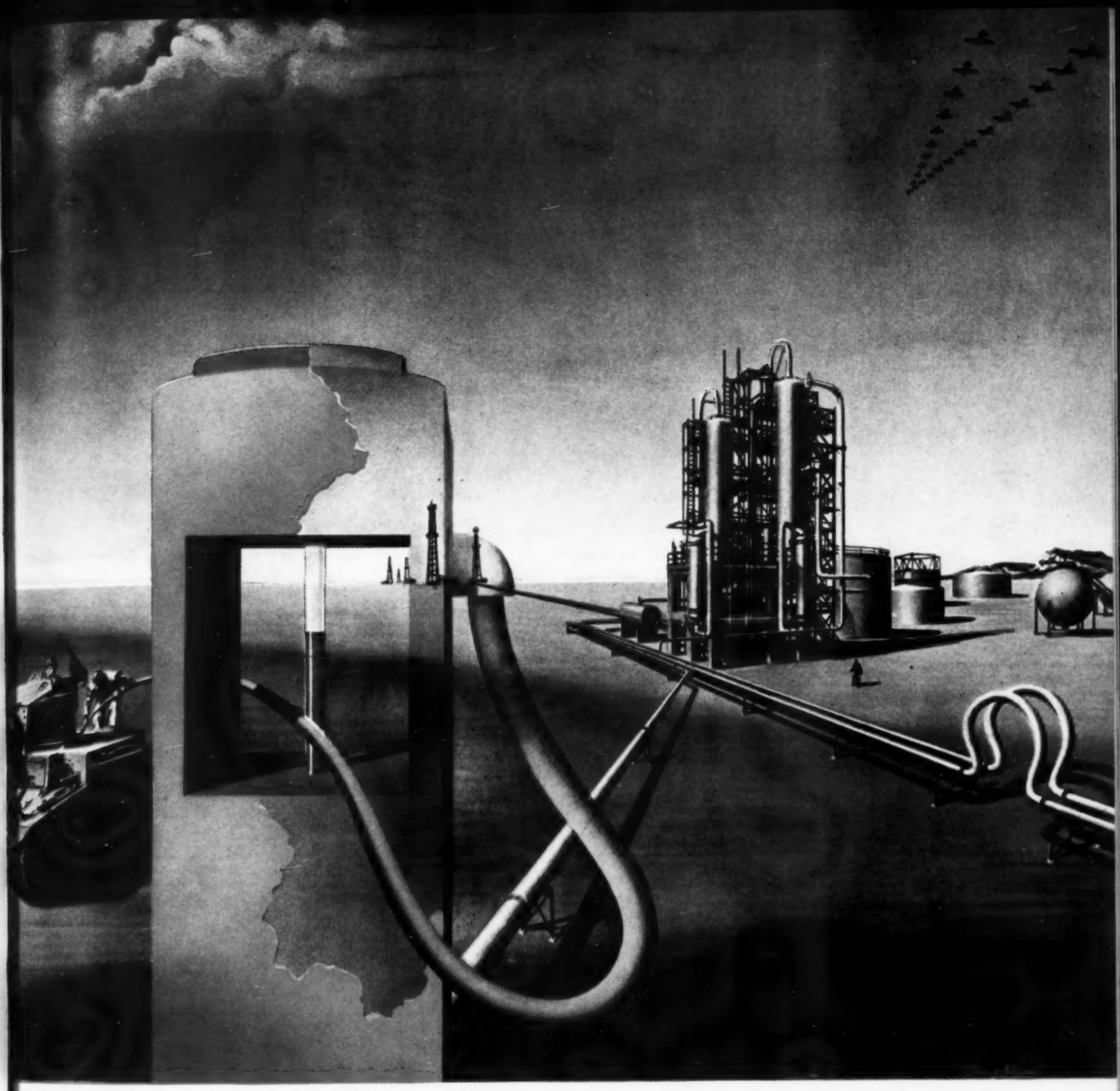

Victory will be measured in gallons

When you hear, with bated breath, how close the enemy has come to a victory with some raid of fifty or a hundred planes, you may wonder what merciful fate kept them from using a thousand. It was more likely lack of *fuel*, not fate, that stayed them.

To reach more oil, the Axis has been flailing about Europe and Asia like a monster, sacrificing lives by the hundreds of thousands.

The American petroleum industry, with half the world's reserves, and a tremendous production of the finest gasolines and oils, is our greatest guarantee of ultimate victory.

For the petroleum industry, Koppers has built plants to remove the corrosive hydrogen sulfide and recover the sulfur in a form that can be readily converted into war-important sulfuric acid.

Koppers produces chemicals to help make gasolines anti-knock; ingredients for the manufacture of inhibitors to prevent gum formation in gasoline; chemicals for solvent refining and dewaxing for the improvement of lubricating oils; chemicals that improve the pour point and film strength of oils.

Among other products which Koppers furnishes to the petroleum industry are piston rings; Fast's self-aligning couplings; pressure treated piling, lumber and timber. In its service to the petroleum industry, Koppers feels that it is helping write the history of the war. Koppers Company, Pittsburgh, Pa.

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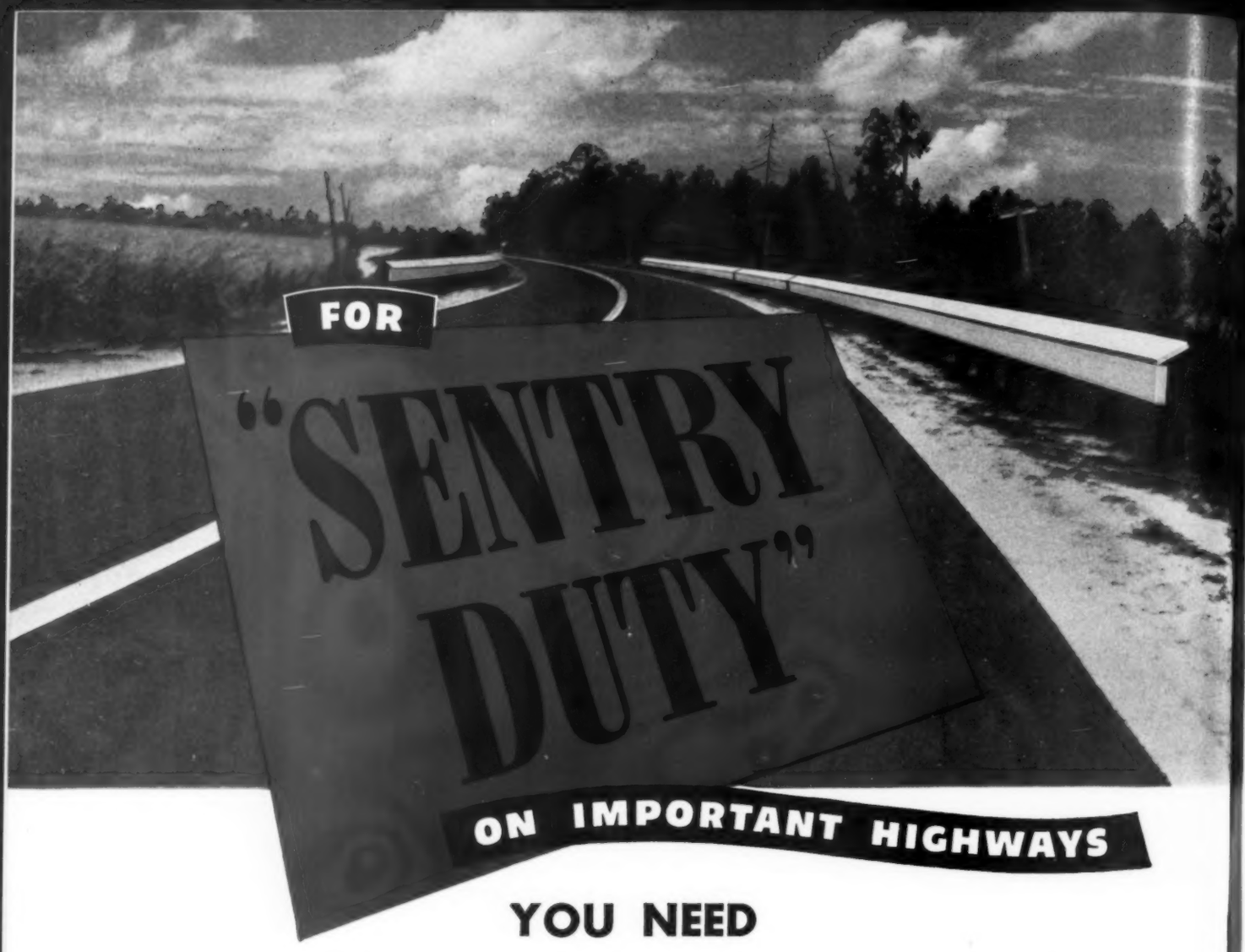

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With all the uncertainty about the possible cost and availability of labor and materials for future maintenance, there's only one safe rule to follow. On today's construction and repair, build as well as you can, with the most durable materials you can get. In the case of highway posts, this means *use pressure-treated wood.*

Bulletin 109 of the Iowa State College of Agriculture ascribes an average life of 30 years to pressure-creosoted pine posts. This is confirmed by railroad and utility experience with pressure-treated ties and poles. The bulletin states further that the life of the pressure-creosoted posts is from two to seven times that of various species of untreated posts.

Guard rail posts and plank pressure-treated with creosote or salts preservative, are available now, for current projects. Salts-treated wood is readily painted for visibility.

The complete story, with facts and figures reported by actual users, is contained in our bulletin, "Pressure-Treated Highway Posts." We believe you will find it interesting and helpful. Ask for a free copy.

WOOD PRESERVING DIVISION
KOPPERS COMPANY
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use K O P P E R S *products*

(*Continued from page* 54)

provided a very satisfactory method to keep traffic moving. Often patches are necessary to provide temporary relief until more permanent repairs can be made. Many patches, if carefully made, will serve as cure for the trouble, particularly if the surface patched is a blacktop pavement. The wide range of bituminous materials available for this work makes its use economical under most any weather conditions.

Mud pumping of pavement slabs that have settled from a true grade has saved many square yards of surface which at one time would have been necessary to entirely replace. These operations are simple, fast and comparatively cheap. The interference with traffic is slight and no barricades on the highway are necessary except during the period of the operations.

The replacement of broken sections of pavements has always been an expensive item of maintenance work. The breaking out of the old sections of pavements has been considerably speeded up with the use of the air hammer breaker mounted on a truck. The shattering of a considerable number of patches in advance of the digging out and replacing operations can be done without closing the road to traffic. Removal of the broken materials is probably the slowest and most costly part of patching operations. Use of mechanical loaders speeds up this work considerably.

After the subgrade has been repaired, and often the reason for the break can be found there, the new patch may be placed. Several new developments can be applied here which greatly improve this portion of the work. Today's knowledge of cement, concrete mixes and admixtures permits us to obtain high early strength concrete which greatly facilitates the work and avoids long curing periods. The restrictions on the use of the highway is thus eliminated except for short sections at the point of operations. The use of transit mix concrete expedites patching operations and avoids the necessity of storing equipment and materials along the road. So, by careful planning and by making full use of present information on materials and equipment, this important phase of pavement maintenance can be carried out with a minimum inconvenience to traffic and maximum economy.

The care of black-top surfaces which include surface treated macadam, penetration macadams and the various bituminous oil mixes and retreads, presents quite a different problem for the maintenance organizations. Any small breaks which occur in surfaces of this type must be given early attention. Neglect will be costly. With the wide range of bituminous materials, both in asphalts and tars, and the various mixes that can be prepared from them, the problem is not difficult.

The application of seal coats on black-top pavements is an important phase of maintenance of this type of surface. The need for these seals varies with the type of surface, amount of traffic and weather. The type of material that should be used also varies for the same reasons. Probably the greatest improvement in this part of the work has resulted not only because of the wide range of materials now obtainable, but also from the improved equipment now available for the application of both the bituminous material and the cover material. Asphalt and tar distributors can be obtained which give very accurate control of the quantity applied as well as the temperature at which it is placed. The mobility of the distributor makes it possible to operate in rather a large terri-

Traffic marker applying new luminous glass bead reflectorized center line paint. Machine simultaneously applys two separate stripes of paint, then applys thin spray of glass bead particles to paint which cements beads to surface

Visibility obtained through use of new luminous glass beaded reflectorized center line paint

Tank truck refueling highway tractor mowers at roadside. This practice saves valuable time which would be lost if machines were forced to return to yard for fuel

tory from one central storage point. Sand, stone and chip spreaders are available which make this part of the operation almost automatic. As a result of these improvements in materials and equipment, seal coats placed today are better and less costly.

Much could be written on the subject of maintenance of unpaved surfaces but I will mention only the major developments which have aided us in getting better results with the funds available.

Materials meeting various specifications for use on particular types of road surfaces are now more readily available than a few years ago. One reason for this is that the modern screening plants which the material producers are using have been so greatly improved. These plants can easily be adjusted to produce different materials or to take care of variations in the material deposits.

Our knowledge of soils today makes it possible to specify materials which are particularly adaptable to the job.

The equipment necessary for the care of unpaved surfaces has all been modernized. Compare the truck scrapers, multiple blade maintainers, and patrol graders of today with the drags, scrapers, tractors and pull graders of a few years ago and anyone can understand why we have been able to keep up the standard of maintenance in spite of the increased traffic, and to keep costs within the limits of the budget.

Stabilization of Surfacing Material is a development which has aided the maintenance men greatly in the care of unpaved surfaces. Existing surfaces which have a surplus of loose material and present a real problem in maintaining a smooth road can easily be tied down by the addition of a binder material. This should not be considered as the construction of a complete stabilized surface but merely as an economical method of getting better results. The use of a previously stabilized material for the light resurfacing of a road avoids the nuisance of a loose, dusty surface, with which we are all so familiar.

Utopia for both the rural road user and the roadside dweller will be reached when all unpaved road surfaces are treated with a dust layer that lays the dust. At present we are all limited to the use of dust layers at points where safety requires it or where it is an economic necessity. Everyone is familiar with the use of calcium chloride and calcium magnesium chloride and knows that good results can be obtained with the use of bituminous dust layers on certain types of surface. The new development in this field is the use of calcium and calcium magnesium chloride in liquid form instead of flake. Development of equipment for the application of this liquid has made possible a substantial saving in dust laying costs, and importantly, permits extension of this service to more miles of road. In Wayne County we have built a truck and trailer distributor with tanks having a capacity of 2,700 gallons. This is used not only for application of the liquid chloride, but for hauling water for surface stabilization.

Snow and Ice

I do not feel that a man from Wayne County should attempt to tell many of you what is new in the field of snow plowing. Our snow fall is light and we have not found it necessary to equip ourselves with anything other than ordinary blade plows. I have read about this heavy snow handling equipment, the use of snow fences, etc., but it is hearsay on my part, so I will make no further mention of it. Our main snow problem consists of picking up the snow in business sections, where we have wide pavements, and hauling it away. All mechanical equipment available for loading snow is used but this must be supplemented by hand shoveling.

However, elimination of icy surfaces is a serious problem with us. The use of treated abrasives is not new but still seems to be the accepted method for taking care of these slip-

Sign truck and crew touching up advance information sign. Truck is equipped with supplies for new installations, repair, maintenance and replacement of signs

WIRE ROPE LASTS LONGER WITH PROPER CARE

8 tips on lubricating WIRE ROPE

You'd have to look a long way to find a piece of equipment able to stand up under the terrific abuse which wire rope handles every day as a matter of course. Just because wire rope *can* take it, however, is no reason to subject the rope to abuses which could be avoided.

Take lubrication, for instance. You wouldn't think of running your car without plenty of oil in the crankcase. Wire rope, too, is a machine. In action, its many individual wires move relative to each other and twist around their own axes. To protect these "bearing" surfaces from rust and from wear, follow the simple rules outlined below. You'll be well repaid in longer service.

1. Clean wire rope carefully before lubricating it. Remove grit, dirt and other foreign matter with kerosene or gasoline and a stiff brush. Another method is to pull the rope through a tightly-wrapped swab.

2. If the rope has been working in a wet atmosphere, it may be coated with hydrated rust—a slimy film that cannot be removed until the rope is *thoroughly* dried out. To apply oil or grease on top of hydrated rust is simply wasted effort.

3. Choose a lubricant which is suited to the size and construction of rope, and to the working conditions. A stiff rope, with fewer, larger wires, requires a heavier lubricant, in general, than a more flexible rope with a greater number of wires.

4. When applying heavy lubricants to wire rope, thin them out by heating, so as to get the desired penetration. Use an ordinary metal vat or box with a gas flame under it. Pull the rope slowly through the hot lubricant. A sheave, partly submerged in the vat, will hold the rope down so that the lubricant can penetrate more readily.

5. If you are not using a heated vat, or a special drip-oiling device, the lubricant may be applied with an oil can or a paint brush, dipped in the lubricant.

6. Don't just apply any-oil-that's-handy to your wire rope. Some lubricants have an acid base and will actually eat into the wires, thus seriously damaging the rope. Be certain that the lubricant you apply to your rope is the correct one—that it won't "fight" with the lubricants already in the rope.

7. Ropes that operate at elevated temperatures require a lubricant that will hold its body at the working temperature. Use a fairly heavy lubricant, heat it above the working temperature of the rope, let it penetrate completely among the wires. It will cool and thicken at room temperature. But in service, the heat will thin out the lubricant to the right consistency.

8. Never let your wire rope rust or become dry of oil. Watch it carefully in service. Experience will show you how often to lubricate for best results. Every type of wire-rope job presents its own lubricating problem. If the load is heavy—if the rope works at high speed—bends frequently around sheaves—is exposed to moisture, grit or corrosive fumes—be particularly careful about lubrication. Remember, wire rope is a machine, and machines don't last long without proper lubrication.

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pery surfaces. Many things have been tried and are still being tried, but I believe most of us have had to return to the use of sand, cinders, slag, or other material treated with calcium or calcium magnesium chloride in order to get results. The objection to this material has been its scaling effect on concrete surfaces. Part of this objection has been eliminated by better control in the mixing and use of this material. The use of abrasives for slippery surfaces has in most cases been limited to intersections, curves, hills, or other danger points as a safety measure. On more important roads it is used more extensively to expedite traffic. The important point is to be organized to apply abrasives as soon as the need for them arises, whether this be during regular work hours, at night, or on Sundays.

Markers and Signs

A highway system would be of little use or benefit to the public if it was not equipped with properly designed signs and markers. The use of distance and direction signs and route markers is necessary to keep highway users informed of their whereabouts, and guide them to their destination. In this class of signs falls the important trunkline marker, the road name signs giving directions and distance to important points, and the little subdivision street name signs. The last of these is important. Without them, the butcher, baker, coal man, postman, etc., would lose time trying to make his deliveries and there would result much confusion.

Warning signs properly placed and designed have made highways much safer for traffic. We are all familiar with the reflectorized warning signs which have added so much to the safety of night driving. The use of the reflectorized road marker aids the night driver by outlining the side of the road. It is particularly effective to guide him around curves, over hills and at other points where there is uncertainty.

The problem of keeping these signs adequate is an important item of maintenance. Rusty, unreadable, broken down signs are worse than no signs. Systematic checking, repairing and repainting of signs should be provided for.

The principle used by automobile manufacturers in the finish of their cars has been tried by Wayne County on sign painting and has proved very effective. A baking oven consisting of two banks of infra-red lights with special reflectors is used for baking the surfaces of all signs. This not only speeds up sign finishing but also gives a tough, durable surface which withstands weathering much better than the air-dried, synthetic and oil enamels.

The effectiveness of stop lines and lane lines has been limited because they were not always too visible at night and because of the short life of the painted line. Many things have been tried to improve the effectiveness of these line markers and only slow progress was made until recently. In 1938 the Wayne County Road Commission applied a sample of zone marking paint in which glass beads were distributed in the paint surface. It was found both effective and long lasting. However, when we attempted to procure more of this material it was not on the market. Last year a marking paint of this type was available and from our experience, and I believe the State has had similar experience, it appears that we now have a zone marking paint which not only is plainly visible for night driving, but is very durable compared with other paints used. Lane lines placed last August on some of our close-in, heavily traveled streets are still amply visible at night.

This line consists of a ribbon of paint, sprayed on with an ordinary marking machine, which serves as a binder for the millions of tiny glass beads which are spread on the surface with a special bead dispenser. These beads act as reflector lenses and make the line appear as a lighted line when in range of the headlights of a car. The cost per mile of line laid with this material is much higher than with ordinary zone paint, but when you consider the lasting qualities and effectiveness, the extra expenditure can easily be justified.

Utilities

The use of the highways for other than highway purposes has been greatly increasing. Public services and utilities have found roads convenient places to locate their water mains, gas mains, sewers, electric conduit and other pipe and cable lines. In many places the regulation of these uses of the highway by permits has become an important maintenance item. Inspection must be provided to give assurance that damage to the highway by the installation and use of it by the utilities, is properly repaired.

Other items of highway service such as operation of traffic signals, the use of the highway for unusual loads and the enforcement of the load laws might be discussed here because the cost of this work is usually charged against the maintenance budget. I feel that these things fall better in the class of traffic control so I will say no more about them.

Picnic tables, roadside parks and comfort stations, trees and roadside development are things which the public is demanding from us today. Where these services have been provided they have been used and appreciated. The money available for them is limited and so this service must be also limited.

The old adage, "A Stitch in Time Saves Nine," has never been more applicable than it is to road maintenance. Much costly reconstruction can be saved if steps are taken to make timely repairs to the road surfaces and structures. I believe we can all point to examples of neglect of which we are not proud. First consideration should be given by highway officials to preserving our existing highways and to providing adequate funds for this work.

Method of Channelizing Traffic at Medial Divider Ends

Diagonal white bars are being used by the California Division of Highways for marking warning areas at medial separations, according to the April issue of California Highways and Public Works.

Using raised plant-mix bars, painted white with traffic lacquer and set at an angle of 45 degrees to the traffic flow, a long pointed segment is constructed gradually separating opposing traffic to the constructed width of the separating area, which is frequently 20 ft. or greater.

One hundred feet or more from the point of maximum width, the point of the separating end divider is laid. From this point, gradually lengthened bars are placed to form an advance warning of medial separation. Standard double traffic stripe eases the traffic from the two-lane pavement to the separated roadway.

To give the line greater night visibility, the stripe is reflectorized with glass beads. To increase the visibility of the bars these, too, are often glass-beaded. Bars are 6 in. to 8 in. in width and increase in height from ¾ in. to 3 in. from the point to the maximum width of the island. Bars are placed from 5 ft. to 20 ft. apart.

The divider is further marked with a standard reflectorized "KEEP TO RIGHT" sign.

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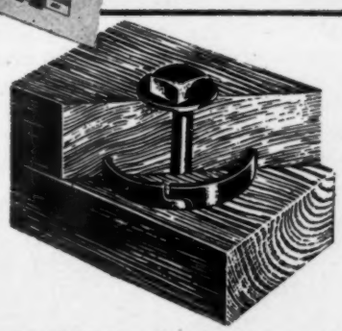

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Patching and Surface Maintenance of Bituminous Macadam Pavements

By JAMES E. LAWRENCE
Massachusetts Department of Public Works
Maintenance Engineer

FOR many years the Massachusetts Department of Public Works has specialized in the development of a bituminous macadam asphalt surface of a high type, but retaining advantages of low initial and maintenance costs. Specifications for construction are varied from time to time as new ideas are developed and as experience dictates, but the basic principle of a flexible pavement constructed of broken stone and bituminous materials incorporated together by penetration methods is still the controlling factor.

In 1908 the first penetration work was attempted by the Massachusetts Department of Public Works when an experimental section of road was built in Wenham using various grades of tar and asphalt products. One and one-half inch stone was spread and rolled and the bituminous material heated in a large movable kettle from which it was spread over the stone by means of a hose and allowed to penetrate into the interstices between the stone. The road was then rolled and covered in different sections with top dressings of sand, gravel, or pea stone.

Development of the bituminous macadam asphalt pavement would not have been possible without the development of the pressure distributor which permits uniform application and penetration of the bituminous material and the use of heavier grades of bitumen. Such a distributor was used successfully in 1911 and 1912 for both new construction and surface treatments, and further refinements in construction methods and equipment in the next few years resulted in the production of the standard bituminous macadam pavement very much like the present pavement with its low initial and subsequent low maintenance costs.

Fig. 1.—Application of ½-inch pea stone to freshly applied asphalt seal coat in connection with surface treatment to bituminous macadam asphalt pavement. The truck is backing up

In view of the close relationship and dependence of maintenance on proper construction, the following outline of latest construction methods of bituminous macadam asphalt pavements is set forth.

Construction Methods

An adequate foundation with the sub-soil properly drained and stabilized must be provided in order to avoid frost heaves, boils, or other distortion of the road surface. Where necessary 12 inches or more of the sub-soil is removed and replaced with clean, sandy, bank-run gravel placed in 6-inch layers and thoroughly rolled. In some cases an adequate foundation is provided by a 4-inch layer of sandy gravel overlaid with 8 inches to 10 inches of stone fill thoroughly rolled.

A broken stone base course usually 4½ inches thick is specified for state highway work. The stone should have a maximum allowable wear of 35 per cent by the Los Angeles abrasion test (A.A.S.H.O. Standard Method T-96-38), and should be composed of 2¼-inch stone or a combination of 2¼-inch and 1½-inch stone. If the mixture of 2¼-inch and 1½-inch stone is used, it should consist of not more than 40 per cent of 1½-inch stone. The shoulders should be built of sufficient width and height to hold the stone in place and should be rolled with the foundation course, the base course, and the top course. The stone should be spread and rolled to a true cross-section of the finished road, any depressions or irregularities being covered with additional stone and rerolled until the surface is true and unyielding. The course is then bound with clean sand or stone dust, the rolling operations being continued and the sand being applied in small quantities until it is just below the top of the stones. The rolling should be done with a 12-ton roller.

The top course is usually constructed 2½ inches thick, and 2¼-inch broken stone of a harder quality than the stone used in the base course is specified, a maximum allowable wear of 25 per cent by the Los Angeles abrasion test being allowed. The stone is spread and rolled to a true cross-section of the proposed road in a manner similar to the method used in rolling the base course until the surface is true and unyielding. Excessive rolling which would tend to crush the stone should be avoided. Before any bituminous material is applied, all dirt or other foreign substances is removed from the surface and any unsuitable broken stone is removed and replaced with clean stone. The stone should be perfectly dry before the bituminous material is applied.

The bituminous material is uniformly applied on the top course of stone by means of a pressure distributor capable of spraying, if required, a width of 15 feet at a pressure between 40 and 60 pounds per square inch. The rate of application is 1½ gallons per square yard. The surface is then covered with ⅝-inch key stone, the stone being applied in light applications as the rolling continues, and ½-inch pea stone is then added in sufficient quantity to completely fill the voids. Before the seal coat is applied, any surplus stone is swept from the surface. The seal coat is then applied in the same manner as the penetration coat but in two applications at the rates of ½ and ⅜ of a gallon respectively per square yard. The first application of bitumen is

Fig. 2.—Close-up view showing texture of finished surface of bituminous macadam asphalt pavement after surface treatment

● America's unmatched system of strategic and secondary highways is playing an important part in the war effort. Road builders have every right to be proud of the part they have played in making possible the speedy movement of men and materials so essential to victory.

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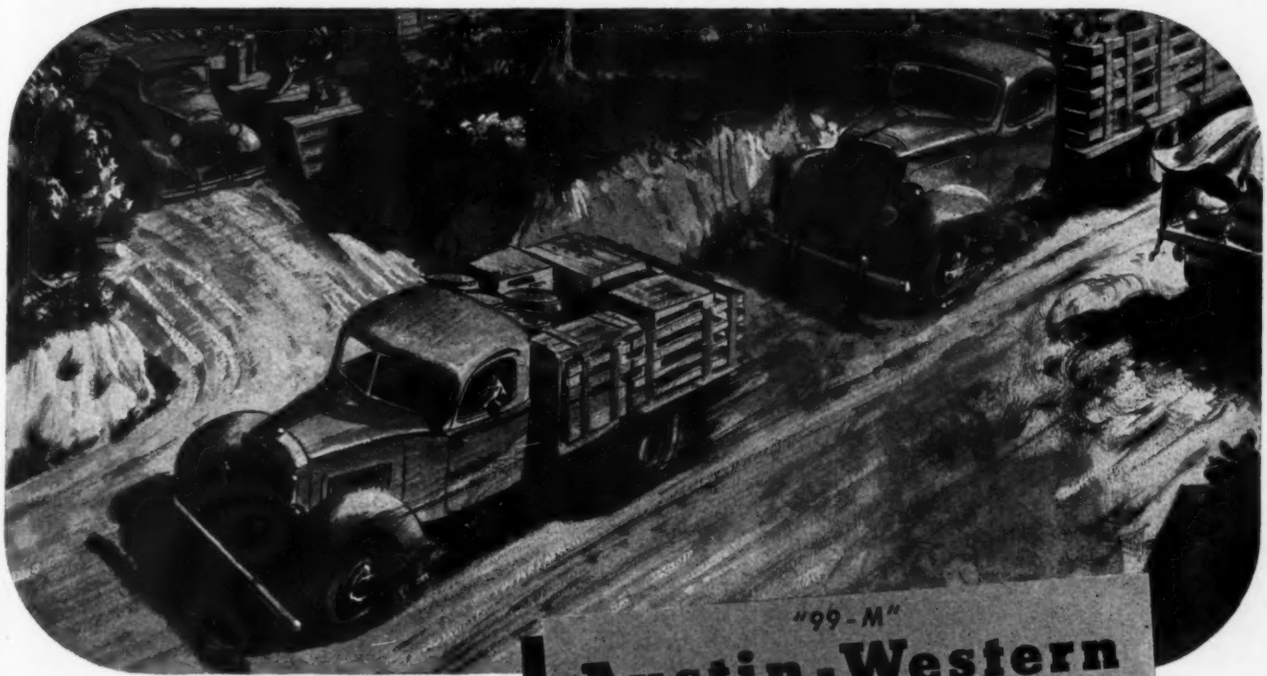

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Fig. 3.—General appearance of bituminous macadam asphalt pavement after surface treatment

covered with ½-inch pea stone in sufficient quantity to take up excess bitumen, and the surface given a thorough rolling. After the second application of bitumen, sufficient ⅜-inch pea stone is spread to take up all excess bitumen and the surface given a final rolling. After the seal coat is applied, any surplus bituminous material on the shoulders is removed in order to permit the shoulders to be rolled in conjunction with the finished surface.

The Massachusetts Department of Public Works has used asphalt to a much greater extent than other bituminous materials. The top course of broken stone is penetrated with asphalt cements (A.A.S.H.O. designation M-20-26), 85 to 100 penetration being specified for the summer months, and 100 to 120 penetration in the spring and fall. A quick setting type of asphalt emulsion (A.A.S.H.O. designation M-51-37) is used for the seal coat.

In the interest of elimination of noise caused by the passage of fast rolling pneumatic tires over the road surface which has been the principal criticism of the bituminous macadam pavement, the seal coat is made in two applications under recently adopted specifications, instead of one as formerly. The use of the smaller ⅜-inch stone in the second coat, together with the application of two coats instead of one, eliminates the open texture appearance of the finished surface and reduces the noise to a minimum.

Maintenance Costs

That the maintenance of bituminous macadam pavement is an important factor in the Massachusetts Department of Public Works Maintenance Department is indicated by the number of square yards of this type of surfacing compared to other types. Altogether there are approximately 30,000,000 square yards of State highway surfacing in Massachusetts. Of this amount, 16,500,000 square yards are bituminous macadam. The bituminous macadam surfacing is composed of approximately 15,500,000 square yards of asphalt macadam and 1,000,000 square yards of tar macadam.

Fig. 4.—Patching bituminous macadam asphalt surface

The ordinary maintenance surface cost per square yard per year averaged over the 5-year period from 1936 to 1940, inclusive, of the more common types of surfacing in use by the department is as follows:

Type of Surface	Aver. Maint. Cost per sq. yd. per year 1936 to 1940 inc.
Sheet concrete (reinforced concrete base course with plain concrete surface course separated by a layer of burlap	$0.0029
Dual type (2 outside lanes of reinforced concrete, middle lanes bituminous macadam asphalt)	0.0035
Bituminous concrete	0.0066
Reinforced concrete	0.0070
Bituminous macadam asphalt	0.0076
Granite block	0.0079
Road-mix	0.0118
Obsolete types	0.0310

Maintenance cost of bituminous macadam asphalt at $0.0076 per square yard is slightly higher than it has been running in the past. This is due to the number of surface treatments applied to bituminous macadam asphalt surfaces during the past few years, and it is not expected that this trend will continue. In spite of the slightly higher maintenance costs of the past few years, this type of surface is considered very economical in view of the low initial cost of the pavement. Averages of construction costs of bituminous macadam asphalt surfacing, including the base course, in recent years indicate a cost of about $1.10 per square yard.

The amount of maintenance work necessary on a well-built bituminous macadam asphalt road is small, a mile of thirty-foot road requiring a yearly average outlay of a little over $130. I am familiar with many miles of bituminous macadam asphalt pavement 20 to 25 years old still in excellent condition, some of which have never received a surface treatment. Occasionally, however, due to an extremely open surface type of construction or to years of subjection to fast-moving traffic, a surface treatment becomes desirable.

The open surface type of construction was developed as the result of an attempt to secure an extremely non-skid surface by the use of a minimum of pea stone at the time of penetration, leaving the 2½-inch stone exposed as a wearing surface. In this attempt the surface was sometimes inadequately sealed, resulting in the need of surface treatments after a few years. The construction of this type of surface is the cause of the recent increase of surface maintenance costs for bituminous macadam asphalt. The present tendency is to use more pea stone so as to insure the complete filling of the voids and to attain thereby a tighter

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surface. It is now felt that with the development of the double seal coat the surface thus attained is just as skid proof, much less noisy, and certain to wear longer before a surface treatment is needed than the more open type of surface.

Patching

A close examination of a bituminous macadam asphalt road needing a surface treatment reveals a honeycombed surface no longer tightly sealed against the elements. If a surface treatment is not immediately applied, the 2½-inch stones begin to work loose and raveling of the surface commences. Before a surface treatment can be made it is necessary to patch areas where raveling has occurred and bring the road to a true cross-section.

Various grades of bituminous material are used in patching asphalt macadam surfaces. In the early spring, in cold wet weather, temporary patches are made with a premix material composed of broken stone aggregate which is varied in size according to the size of the hole to be patched from about 1½-inch stone down to ¼-inch stone, and cold patch tar. In warmer weather similar premix patches of small areas are sometimes made, using rapid curing cut-back asphalt of relatively low viscosity instead of the cold patch tar.

Under favorable weather conditions permanent patches are made of asphalt cement (A.A.S.H.O. designation M-20-26) to match as nearly as possible the texture of the surrounding surface. All loose material is removed from the area to be patched, and the resulting cavity is carefully cleaned. The area is generally painted with the bitumen, and broken stone graded to the requirements of the area deposited therein. The stone is thoroughly tamped or rolled and keyed and the bituminous material (frequently 85 to 100 or 100 to 120 penetration grade) potted in or applied with a spray unit.

Except to correct for roadbed settlements or settlements due to excavating for underground public utility structures, patches of more than 2 or 3 square feet in area are seldom necessary on asphalt macadam surfaces. If they become necessary, the surface course is entirely removed and a new surface is built up from the base course exactly as in new construction work. The area to be patched is laid out by the use of a chalk line or straight edge, and the edges cut vertically with square corners. A tack coat is generally applied to the edges before the broken stone is placed.

Fig. 5.—Newly constructed bituminous macadam asphalt pavement showing closely sealed type of construction

The unit cost of a patch of this type varies not only with the location, which is a factor of the material cost, but with the size and proximity of one patch to another. The cost would vary upward from a low of about $1.50 per square yard.

Retreatment of Surfaces

Before placing the surface treatment application which is made after completion of necessary patching, all sand and other undesirable material must be removed from the road surface. If considered necessary, the road is swept with mechanical sweepers or with hand push brooms.

Rapid curing cut back asphalt (A.A.S.H.O. designation M-81, latest revision), grade RC-3, is used with a great deal of success in the spring and fall, and grade RC-4 in the summer. Asphalt emulsion (A.A.S.H.O. designation M-51-37) is also highly recommended.

The surface treatment application is made at a rate of from 0.20 to 0.40 gallons per square yard, the rate having been previously determined by examination of the road. One-half-inch pea stone is spread over the freshly applied asphalt at a rate of 20 to 40 pounds per square yard depending also on the previously determined condition of the road and the quantity of asphalt applied. If further refinement is considered necessary, the pea stone is more evenly spread over the surface before rolling by use of a strip of close woven wire fencing 6 feet to 8 feet wide and 8 feet to 10 feet long dragged over the surface. The road is then rolled just enough to insure the settlement of the pea stone into the interstices between the larger stones, and to smooth out and thoroughly compact the surface treatment material. Too much rolling will cause crushing of the pea stone cover and should be avoided.

Another type of surface treatment or seal coat with which excellent re-

Fig. 6.—Newly constructed bituminous macadam asphalt pavement showing a more open type of surface

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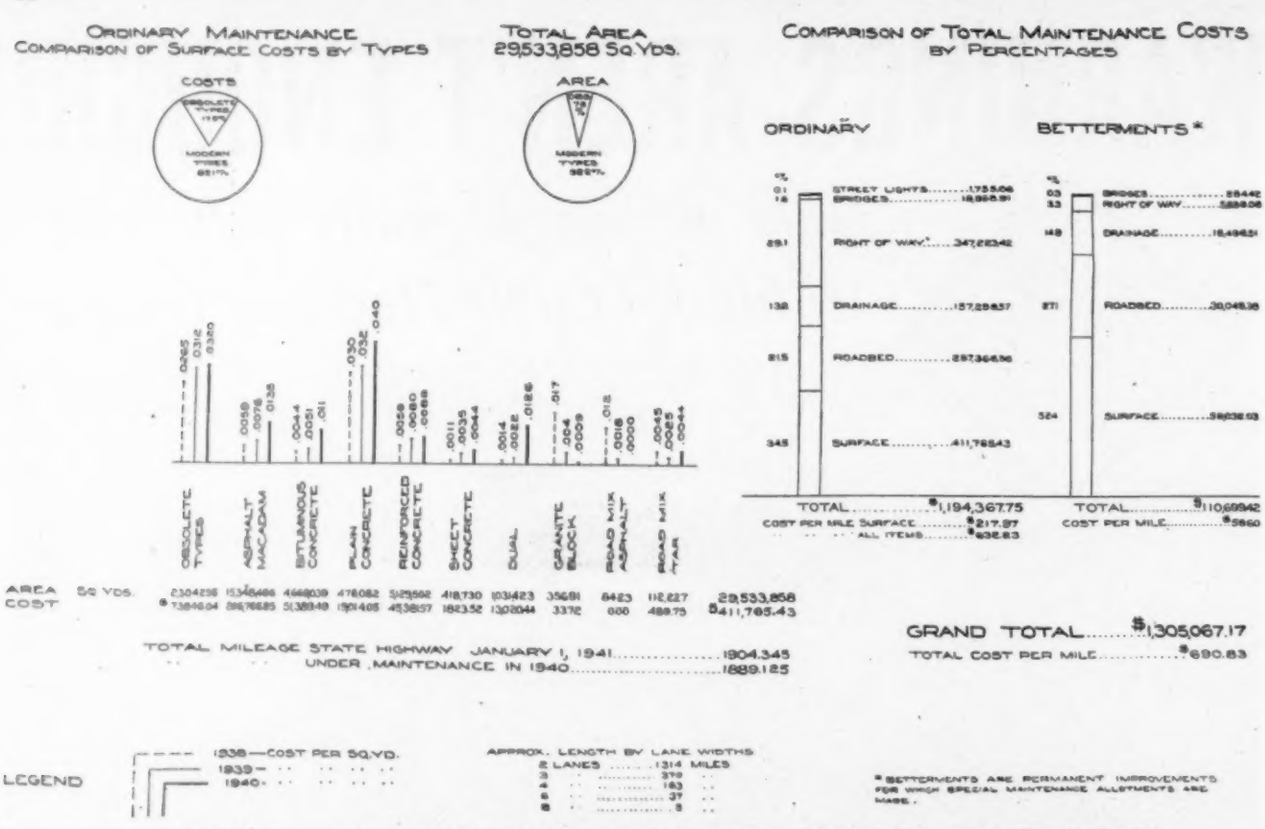


Fig. 7.—Maintenance costs for year 1940 of the Massachusetts Department of Public Works; prepared in April, 1941

sults have been obtained, calls for the use of 85 per cent asphaltic oil (approximately grade SC-5 of the proposed specifications of the A.A. S.H.O.). A hot application at the rate of not more than 0.25 gallons per square yard covered with ¾-inch pea stone produces a highly non-skid surface of extreme durability. As with all surface treatments, poor results may be expected if the work is done during rainy weather unless an anti-stripping compound is used.

Anti-Stripping Compounds

There are a number of pretreatment anti-stripping compounds on the market for use in connection with patching or surface treatment work which have certain merits. Most of these compounds work very well in wet weather and are, therefore, very useful in patching a bituminous macadam surface in the spring. In making surface treatments, because of the close adhesion of the asphalt and aggregate, less stone is lost through the action of traffic, and the amount of stone used may be reduced. Also, in case of a rainstorm occurring during the operation, the stone will still adhere to the asphalt.

Causes of Cost Variations

The cost of a surface treatment to an asphalt macadam road varies not only with the amount and type of cover used, but also with the locality, which greatly affects the cost of materials. A study of surface treatments made during the last few years, however, indicates an average cost of about $1,400 per mile of 30-foot road, which figures about 8 cents per square yard.

The accompanying chart, figure 7, showing maintenance costs for the year 1940, is prepared annually and is self-explanatory. Note the average surface maintenance costs per square yard per year which are given for the more common types of surfaces for the past 3 years, and also to the areas of the various types of surface under maintenance during 1940.

Retain Experienced Men

The importance of retaining a well-trained experienced crew of skilled laborers on maintenance work is stressed. The value of experienced labor is well illustrated in the single item of "patching." The knowledge of the correct grading of aggregate to use in a particular patch, and of just how much material to use to attain a smooth surface with an even grade, the correct amount of compaction, and in a penetration patch just the right amount of bitumen to completely fill the interstices without creating fat spots, is acquired only through years of experience. The retention of such a force in view of the present war effort is likely to become extremely difficult, but insofar as possible in the interest of low maintenance costs, key men thoroughly familiar with the intimate details of maintenance work should be retained.

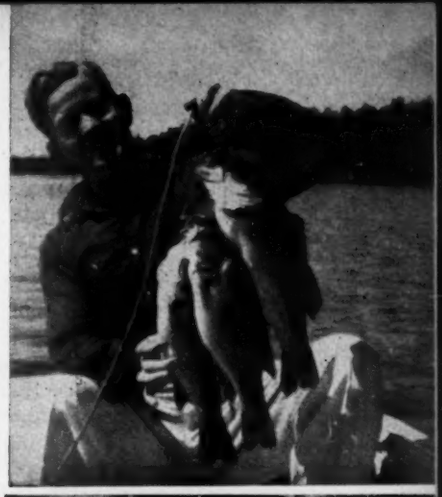
▼

65 Per Cent of Motor Vehicle Travel Is for Business Purposes

According to a report in the April Public Roads by Robert H. Paddock, Highway Engineer Economist of the Public Roads Administration, approximately 65 percent of all motor-vehicle travel in the United States is for "business" purposes, or in connection with such essential activities as earning a living or maintaining the home. Data on this subject were obtained in the road-use studies conducted as a part of the State-wide highway planning surveys that were initiated in 1935.

▼

A.S.T.M. to Meet at Atlantic City.—Over 100 technical papers and committee reports are scheduled for presentation at the 1942 (45th) annual meeting of the American Society for Testing Materials to be held June 22-26 at the Chalfonte-Haddon Hall, Atlantic City, N. J.



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EDITORIAL

Is It an Overpass Or an Underpass?

FREQUENTLY engineering terminology, even among engineers is ambiguous. Let us consider the terms "overpass" and "underpass." When speaking about a highway structure which crosses above a railroad, canal, area, or other construction, the term "overpass" is generally accepted, provided the grade line of the road crossing such other construction departs from its general grade trend, and returns after the crossing to that general grade trend. Likewise with an "underpass" which crosses beneath such constructions. If the structure carries the road over a canal, river, railroad or other construction or condition without an abrupt change in the general grade line trend, it is usually referred to as a "bridge." However, this is not always the case, there is ambiguity of terminology in this case.

Now when we come to discuss the condition where one highway crosses another highway at a separation, our terminology is completely inadequate. Let us refer to the Benson, Arizona, grade separation project which was described in the April issue of ROADS AND STREETS. The structure which carries State Route 86 under the Southern Pacific Railroad is well understood to be an "underpass" from the highway point of view. Continuing north on State Route 86, this road passes under U. S. 80, and then rises to the level of the surrounding terrain. Is this structure an "underpass" or an "overpass"?

In the same issue of ROADS AND STREETS is an article describing Colorado's first cloverleaf construction. To avoid confusion of terminology the author of that article called all of the structures "bridges." In this case the North Bridge and the South Bridge are structures carrying access roads over the main north and south route U. S. 85. The C. B. & Q. R. R. and the U. P. R. R. were carried over U. S. 85 on two other bridge structures. South of these four bridges, U. S. 85 is carried over Sand Creek on a bridge.

Undoubtedly the two railroad structures can be called "underpasses" from the highway point of view, with complete general acceptance. But what are the other two structures, North Bridge and South Bridge? Are they "overpasses" or "underpasses"?

To start thinking on this ambiguity of terminology the writer suggests that the base of reference be the general, most uniform grade line trend. Any structure which crosses above the most uniform grade line trend on a line the grades of which have to be broken quite definitely to make the crossing would be termed an "overpass." In like manner, if a quite definitely broken grade line is separated from a general, more uniform grade line trend by a structure in which the more broken grade line passes beneath the more uniform grade line trend, the structure would be an "underpass."

According to these conceptions of structures, the bridge which separates U. S. 80 and State Route 86, on the Benson, Arizona, grade separation project, would be an underpass, because the grade line of State Route 86 breaks to pass beneath the more uniform grade line of U. S. 80. In the case of North Bridge and South Bridge on the Adams City clover leaf project in Colorado, these would be "overpasses" because the grade lines of the approaches to each structure are more definitely broken than the grade line trend of U. S. 85 in the area. These latter two structures carry cloverleaf access driveways up and over the more uniform grade-lined U. S. 85.

Statements have been made that the base of reference for this nomenclature should be the most important road. The writer feels that this base is not satisfactory because of two reasons: 1. Only local persons know which road is most important from the traffic volume point of view; 2. If two intersecting roads, both of heavy traffic volume were separated at an intersection, it would be impossible to state which was the most important. Particularly would this apply to someone unfamiliar with the locality.

Basing the definition of the terminology on the physical aspects of construction, using the most uniform grade line as the base of reference, would clarify the present ambiguity.

Taken for Granted

AS one drives the mountain roads of the West one is constrained to marvel at the audacity of the highway engineer and contractor in combatting the rugged terrain. One road which impressed the writer was the crossing of the Superstition Mountains on U. S. 60-70 in Arizona. This is cited merely as an example. The less rugged route from Los Gatos to Santa Cruz in California, while being hewn out of a heaved up section of old ocean bottom is just as daring in its magnitude and in its conquering of the majesty of nature. One could cite many examples throughout all of the Western States where the ingenuity of the locator, the perseverance of survey parties, and the determination of the contractor was taxed to provide a smooth surfaced roadway for traveling motorists.

From desert heat to frigid altitude the highway engineer and contractor have battled the elements, battled gravity, battled either a flood of water or a drouth of water to push to completion those arteries of traffic over which flow the business, commerce, vacationing and sightseeing motorists of the country. As we speed along little do we realize the painstaking efforts, the blood, the sweat, the sorrow and the joy wrapped up in the completed road. The teamwork of our highway engineers and contractors has become so commonplace that we now take their results for granted, little realizing how easily this war is disrupting, even destroying their continued cooperation in the extension of these populace unifying enterprises. As surely as the sun rises, roads are the one big factor responsible for interregional and intersectional social advancement.

To protect these social developments and advancements we are at war. Let us hope that their continued progress will not be long delayed. Let us, each one of us, do our share as well as we know how, in helping our government to destroy those forces which are striving to destroy us. New road construction for the benefit of our social and economic development will have to be curtailed until the battle against our enemy forces is won. Win we will; but when the holocaust is over and we begin to recount the needs for reconstruction of our highway facilities we will find that we will have a huge program to execute.

When that time arrives, our engineers and contractors will once again shoulder the task of harnessing the forces and subduing the massive forms of nature.

Will Bombing Defeat Germany?*

By **HALBERT P. GILLETTE**

Probably no revolutionary development in warfare was ever recognized as such at the time of its invention. Certainly this was so as to gunpowder, the steamship, the machine gun, the airplane and the "tank." It is also noteworthy that the last men to admit that a revolutionary invention had been made were the very men who should have perceived its merit first—namely those in high command. Witness Napoleon refusing even to be interviewed by Robert Fulton.

About the same time Alexander J. Forsyth patented the fulminate cap, but "This important improvement in firearms was not recognized and adopted by the military authorities until more than 30 years later."

The experience of centuries is often expressed in a maxim, such as, "You can't teach an old dog new tricks." Since "old dogs" are usually in high command, perhaps we need look no further for the reason that history abounds in examples of the slowness with which meritorious new ideas have been adopted. There is, however, another psychological factor that often obstructs progress, namely conceit. Conceit leads to belittling another fellow's achievement, in order to aggrandize oneself. Defects there usually are in any new device which a conceited critic harps upon.

The German Example

In 1940 the Germans were ineffectively trying to bomb Britain into submission. Their failure was interpreted by many high military authorities as proof that they had always been right in regarding bombing planes as incapable of winning a war. To which De Seversky replied, "One might as reasonably argue that guns cannot kill tigers because a volley of buckshot cannot do it."

The heaviest German attack on any English city consisted in dropping 400 tons of high explosive in one night. The bombers were relatively small, and their numbers relatively few. The time is not far distant when 3000 British and American bombers will unload 12,000 tons of bombs in a single night on a German city.

"No flesh and blood, no Nazi will power, no air defenses, no patriotic exhortations, can possibly withstand such fury. It can produce only one answer—the collapse of Nazi Germany." This is the conclusion of F. V. Drake as expressed in the March issue of the Atlantic Monthly. He and De Seversky marshal facts in that issue, the inferences from which seem very convincing to a nonmilitary man.

The reasoning of the airplane "visionaries" like the late Gen. Billy Mitchell and Maj. De Seversky runs like this: Modern wars are highly mechanized conflicts. Hence the major strategy should be the capture or destruction of the enemy's factories and means of transportation.

Which Is Correct?

The bombing plane is the most effective device for this purpose; but to be thoroughly devastating it must be very large and sent against enemy factories in such superior numbers and with such superior fighter-plane protection that it cannot be thwarted. This can be done by the combined effort of America and Britain against Germany first, and Japan later. But military leaders still cling to the belief that the airplane is merely an important accessory to an army or a navy, and not the converse. We are about to see which theory is correct.

One is tempted to speculate about a similar conflict of theories in the

* Reprint from the Los Angeles Times of May 4.

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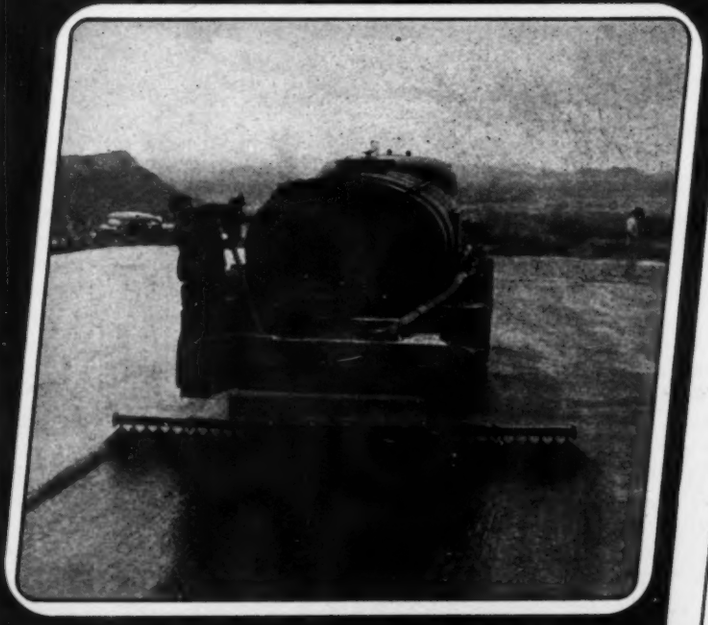

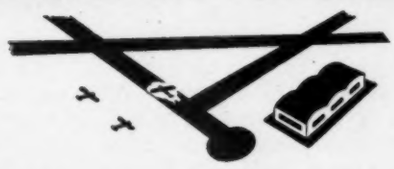

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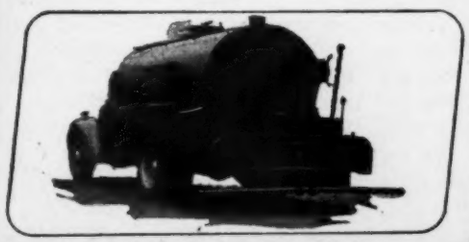

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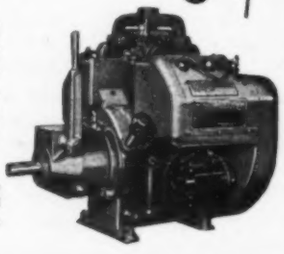

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very ancient past, when bows and arrows were novelties. Probably the "visionaries" and the "standpatters," namely the arrow advocates and the stone-ax advocates, bitterly assailed one another's opinions every night as they squatted around their cave fires. Being more numerous, there is little doubt that the "standpatters" won the debate—and lost the next battle.

Instrument for Recording Motor Vehicle Speeds

An electronic roadside timer for determining the speed of motor vehicles has been developed by the Division of Highways of the California Department of Public Works. The instrument is described by R. M. Rieth, District Traffic Engineer, in the May issue of Public Works.

The complete assembly consists of: (1) a two-beam light unit and a 6-volt storage battery; (2) a two-beam photo-cell receiver unit; and (3) an amplifier unit and meter. The photo-cells and amplifier secure their energy from the regular 6-volt car battery in the car, operated by the recorder. The two small lights in the light source draw approximately 5½ amperes. The average storage battery will operate these continuously for 16 hours or longer. The total current drain of the photo-cells, amplifier, and meter is only 3½ amperes, and the regular car battery is used.

The traffic speeds are read and recorded manually. Experiments are now under way to obtain the automatic recordation of speeds. The length of base line is 17.6 in. The heaviest unit weighs 55 lbs. It can be set up by one person anywhere, day or night, in less than five minutes. Most of this time is required to accurately align the eight beams upon the photo-cells. However, this has been reduced to a minimum by installing low-power, telescope rifle sights, with cross-hairs, on each unit.

The accuracy of the meter is dependent upon the initial graduation of the meter scale. This was done with a synchronous motor-driven propeller with wide blades. Speed of the motor was regulated to accurately break the light beams at a known time.

During this test it was discovered that a base line of 17.6 in. would give even 10 and hundred increments as a reciprocal of even miles per hour. For example, one-thousandth of a second time-interval between breaking of the two beams equaled 100 miles per hour.

The meter can be set up and operated by any one who can hook up a radio to the antenna, ground, and plug the cord into an outlet. Operation is as simple as tuning a radio in the home. It is impossible to connect the meter incorrectly.

After the instrument has been set up, and the switch turned on, it takes about one minute for the tubes to warm up. The meter needle moves to the speed at which a vehicle is traveling as it passes through the beam and remains at that point until the reading is cleared by pressing a button. Other passing vehicles do not affect the reading until the meter is cleared. If the meter fails to operate, it is because the light beams are not properly focused upon the photo-cells.

Eastern Photoelasticity Conference to be Held in June.—The 15th semi-annual meeting of the Eastern Photoelasticity Conference will be held on Saturday, June 20, 1942, at The University Club, 40 Trinity Place, Boston, Mass. All inquiries should be addressed to W. M. Murray, Room 1-321, Massachusetts Institute of Technology, Cambridge, Mass.

New Plans for FWA Operations

Brigadier General Philip B. Fleming, Federal Works Administrator, on May 27, announced a plan of reorganization to draw closer together, and coincidentally to decentralize further, the operations of FWA and its constituent agencies.

The constituent agencies are the Public Roads Administration, the Public Buildings Administration, the Work Projects Administration and the Public Works Administration. Other FWA operations chiefly affected are those pertaining to the war public works or community facilities program, which in larger part have been carried on directly by the FWA engineering organization functioning under the Office of the Administrator.

In the new plan FWA will function, under general direction from Washington, through nine Regional Directors, of whom six were appointed on May 27.

Each Regional Director will operate with a staff soon to be selected and will work as closely as possible with the field organizations of all the constituent agencies. Details of these relationships will be worked out in the light of needs and experience.

The new plan of organization replaces a preliminary plan under which FWA maintained regions varied in number from time to time, with areas somewhat different from those now designated, and with Regional Representatives of the Administrator having a limited coordinating function but no administrative authority.

The new Regional Directors, with their regional offices and regional areas as presently defined, subject to change as experience dictates, are:

New England Region, headquarters Boston, Regional Director James A. McConnell. Mr. McConnell was formerly Regional Engineer at New York.

New York, New Jersey, Pennsylvania Region, headquarters, New York City, Regional Director John M. Gallagher. Mr. Gallagher was formerly Regional Representative in New York.

Middle Atlantic Region, embracing Maryland, Delaware, Virginia, West Virginia, North and South Carolina, headquarters Richmond, Va., Regional Director Kenneth Markwell, formerly Project Engineer of the Santee-Cooper, South Carolina and High Point, North Carolina power projects. The Washington Metropolitan District area will be under the charge of Henry J. Sullivan as Associate Regional Director for this region. Mr. Sullivan lately was put in charge of the war public works projects in this metropolitan district area.

Southwestern region, embracing Texas, Oklahoma, Arkansas and New Mexico, headquarters Fort Worth, Texas, Regional Director James W. Bradner, Jr. Mr. Bradner formerly was Regional Representative in this area, which then embraced also the State of Louisiana. Louisiana will be added to the Southern region, with neadquarters at Atlanta.

Pacific region embracing California, Nevada, Utah, Arizona, headquarters San Francisco, California, Regional Director Pierce Williams. Mr. Williams was formerly Regional Representative in this region.

Northwest region embracing Washington, Montana, Oregon, Idaho, headquarters Seattle, Washington, Regional Director L. R. Durkee. Mr. Durkee was formerly Regional Engineer of FWA in this region.

Regional Directors for the Southeast, with headquarters at Atlanta, and for two groups of Middle Western states, with headquarters respectively at Chicago and Kansas City, will be announced later.

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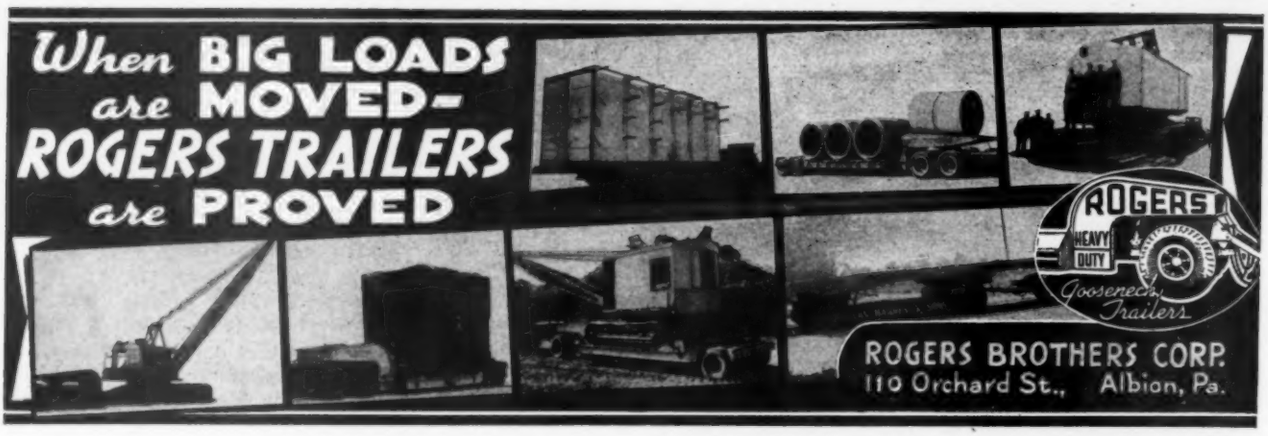

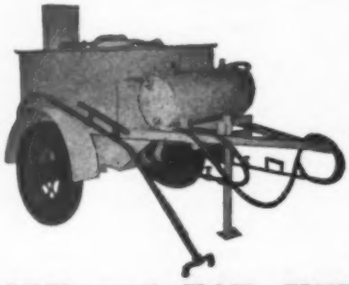

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Write for Catalog No. 601

(Continued from page 61)

publicly and privately financed war housing. It works closely with other housing and related agencies in the Government, reviewing with them such matters as the type of housing as it relates to the use of materials, availability of utilities, services, etc.

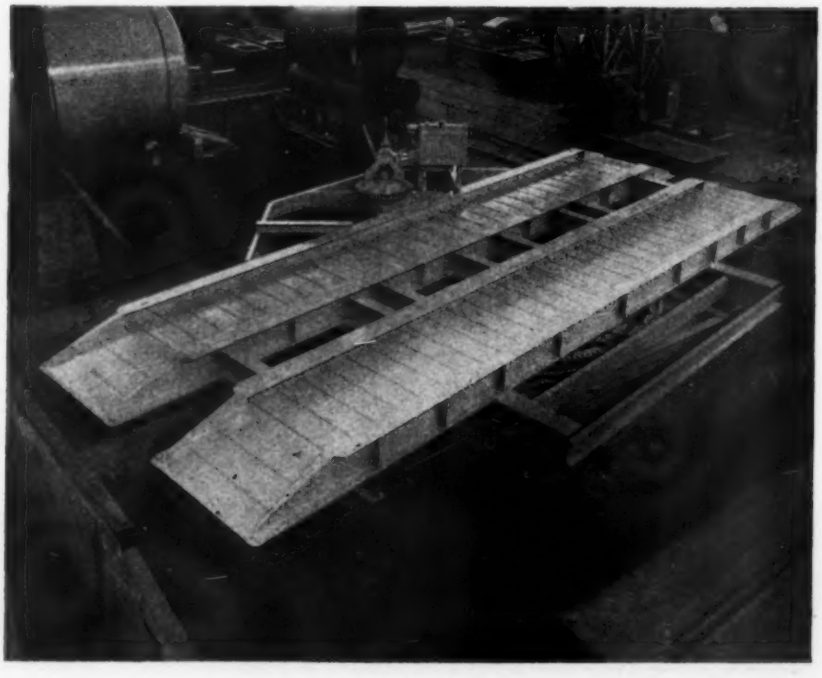
The Consultation Branch acts as liaison between the public and the Bureau. It interprets the needs and problems of the construction industry and recommends procedures consistent with the over-all war program. Through its knowledge of trends and the requirements for essential military construction, the Branch recommends the issuance of Limitation and Conservation orders and amendments, as may from time to time become necessary.

Direction and decisions of the Bureau will be handled in the New York Office.

All contacts with Federal, State and local Government agencies in regard to applications concerning their construction projects are the function of the Bureau of Governmental Requirements, under the direction of Maury Maverick. This Branch, part of the Division of Industry Operations, will remain in Washington.

Truck Turntable Handles 55-Ton Load

Built by Blaw-Knox Co., Pittsburgh, for use by contractors at a Pacific Naval air base, this truck turntable is believed to be one of the largest ever constructed. It will handle 3-axle, 188 in. wheel base, Mack trucks which, including pay load, weigh 55 tons. The turntable is self-powered with a gasoline engine for turning.



Gas Rationing for Trucks

Regulations of the Office of Defense Transportation will control the amount of rations to be issued trucks, buses and government operated cars under the new coupon plan for gasoline rationing which the Office of Price Administration will put into effect on the East Coast next month.

The rationing plan, itself, will not restrict operations of these vehicles, but they will not receive more gasoline than will be required for carrying out the operations permitted by ODT.

Trucks, buses and certain passenger car types operated for commercial or governmental purposes, will apply for "S" coupon books. These applications will be filed with a local rationing board, or, if the vehicle is operated under an Interstate Commerce Commission license, at a local office of the Office of Defense Transportation.

How to Conserve Replacement Parts for Trucks

The Maintenance Section of the Division of Motor Transport has offered valuable suggestions, all based on long practical experience in parts rebuilding. Among the typical parts — reclaiming procedures suggested are the following:

1. A drive shaft, worn at the joints because of neglect, need not be scrapped. It can be rebuilt. Two new universal joints to replace the worn parts may be welded to the old tubes to make a serviceable assembly. If the splines on the old tubes are worn they can be plated to any desired thickness to compensate for the wear. Thus, two new joints, a minimum amount of welding wire and plating material suffice to reclaim an entire propeller shaft assembly.

2. A crankshaft, so worn at main or connecting rod bearing surfaces that a regrind to a smaller available standard size is impossible, need not be scrapped. The mechanic who is familiar with the process known as metal coating can reclaim the shaft with excellent results. This process has many possibilities in the automotive field for the purpose of replacing worn material. Only a few simple rules must be followed to assure complete success. Sprayed parts must not be stressed excessively. There should be no fatigue cracks in the foundation to be sprayed. Preparation of the foundation should assure keying and dovetailing deep enough to withstand any mechanical pressures involved. The foundation material must be clean and free from oxides, oil, dirt and water. The sprayed metal must be atomized finely to insure the molten particles being small enough to penetrate the openings in the prepared foundation. Preparation of the foundation is accomplished by blasting with a special grit or machining with special tools. Hardened surfaces must be removed before preparation.

The worn bearing areas should be ground to the desired depth to assure uniform thickness of the finished sprayed material. The undercut surface is then shot blasted or machined. The prepared area is sprayed with the metal selected and the coated area is then finished by grinding or machining to the required size. By this method an expensive crankshaft may be reclaimed and brought back to its original dimensions at one-third the cost of a new shaft.

3. Valve faces, after several grindings, may lose enough material to reduce the valve-head dimensions to the point where they seat too low in the cylinder head or block. Hard surfacing materials can be welded to the valve face in much the same manner new aviation valves are made. This method of reclamation restores the valve to its original dimensions and provides a hard, heat-resistant face.

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Write for Bulletin No. 115

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To facilitate the business of Americans, and in the interest of war production, there is augmented service at the great metropolitan hotels of Los Angeles, Hollywood, Long Beach, San Diego and the other large cities of Southern California.

There are no rations of fun at the fine resort hotels located on the desert at Palm Springs; by the sea at Coronado, Carlsbad, Laguna, La Jolla, Santa Monica and Santa Barbara; and amid the beauties of Pasadena, Beverly Hills and Riverside. Health and energy still bubble from the earth at the famous mineral springs resorts.

Golf, tennis, riding, cycling, badminton and a multitude of other sports and recreations are still to be enjoyed every day of the year by the visitor to this sun-blessed land.

Hotel rates in Southern California will continue at pre-war levels. Nowhere is there a greater variety of hotel accommodations to suit every budget and every taste.

In spite of rumors, travel is normal in Southern California. Transportation to and throughout the state is normal, and hotel and resort life is normal.

For further particulars, consult the nearest travel or transportation agent or your automobile club.

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Box 2, Room 701, 629 South Hill Street, Los Angeles, California

New Division Created to Administer Added Authority Over Highway Transportation

Joseph B. Eastman, Director of the Office of Defense Transportation, has named John R. Turney as Director of the newly created Division of Transport Conservation to administer the extended authority over highway transportation (including private passenger automobiles) given the O.D.T. by an executive order made public May 4. Henry F. McCarthy has succeeded Turney as Director of the Division of Traffic Movement of O.D.T.

Under O.D.T.'s interpretation of the executive order, it will be the duty of the Division of Transport Conservation to formulate policies, programs and measures for:

1. The continuous adjustment of national transportation requirements and available transport services;
2. Conservation of motor vehicles, tires, motor fuels, and materials;
3. Conservation and distribution of transportation service and to the *extent necessary, its restriction to essential needs.*

The programs and policies formulated by the new Division will be administered, in part, through established divisions of O.D.T. and, in part, through other agencies of government, especially the local rationing boards of the Office of Price Administration.

Director Eastman announced that the Division of Transport Conservation will work in close cooperation with the Office of Petroleum Coordinator, branches of the War Production Board and the Office of Price Administration, in dealing with rubber, gasoline and passenger automobiles.

Under date of February 1, 1942, twelve national highway user organizations, all members of the National Highway Users Conference, strongly recommended in a joint public statement that the Office of Defense Transportation be given the authority included in the executive order released May 4, and that the Director of Defense Transportation be made a member of the War Production Board.

Hill-Climbing Ability of Motor Trucks

The problem of eliminating the traffic congestion that results from slow-moving vehicles on grades has been investigated by the Division of Transportation of the U. S. Public Roads Administration in an exhaustive study of motor truck performance. The investigation and its results are reported by Carl C. Saal, Associated Highway Engineer Economist in the May issue of *Public Roads*. The investigation is summarized as follows:

The study was divided into three distinct but closely related parts: a study of the performance of new motor trucks in the best of condition; a study of the performance of used motor trucks in various stages of wear and having traveled various mileages; and a study of the hill-climbing ability and the driver behavior of a large number of motor trucks and passenger cars as they operate in every day traffic.

Actual grade tests, the most important part of the new truck study, were made on 30 new truck chassis. The results of these tests showed that for motor trucks even to approach reasonable speeds on grades: grades must be reduced to 3 percent or less; or engine power must be more than doubled; or gross vehicle weights must be reduced excessively; or some combination of the three must be used that will still be costly to all interests involved and impossible of immediate application.

Deceleration tests were made on each new truck to determine the coefficients of tractive resistance. The most significant finding was that not

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This fleet of Hercules 8X SPEEDRAULIC Hoists and 6 cubic yard dump bodies is typical of the type of equipment relied on by contractors when every load counts. Dump truck equipment built to do a big job in a hurry, with power to handle large, heavy loads TODAY—AND EVERY DAY.

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only the total tractive resistance but also the unit resistance in pounds per 1,000 pounds varied appreciably with weight. The efficiency of the transmission of power was also determined for each new vehicle from the results of the actual grade tests. The evaluation of these two factors makes it possible to compute the performance of a motor truck from its specified characteristics with a fair degree of accuracy.

The results of the actual grade tests were also used to appraise cheaper and shorter methods for determining the grade ability of motor trucks. The acceleration method proved to be the most satisfactory and was adopted for use on the used truck study.

Tests on 17 used trucks of the same make and model as the new trucks tested showed that not over a 10 percent decrease in performance should be expected from wear and mileage. The results also proved definitely that trucks can be maintained so that their performance does not decrease with reasonable use.

The study of motor trucks in actual service under ordinary driving produced results that showed a 30 percent variation between the possible performance and the actual performance of vehicles of the same weight and capacity. Since not over 10 percent of this variation should be due to lack of maintenance, there remains a 20 percent variation that must be charged to improper operation of the vehicle. The shifting of gears at improper speeds was the principal reason for the variation in performance.

The conclusions resulting from the study are given as follows:

The most important conclusions are derived from the results of the actual grade tests and the applications described. They showed that for motor trucks even to approach reasonable speeds on grades:

1. Grades must be reduced to 3 percent or less, or

2. Engine power must be more than doubled, or

3. Gross vehicle weights must be reduced excessively, or

4. Some combination of the three must be used that will still be costly to all interests involved and practically impossible of immediate application. Before a final conclusion can be reached, the reasonable minimum speed must be determined and the relative economics of the three basic methods and of their combinations must be determined. The results do show plainly that it will not be possible to find a comprehensive solution. It appears that the immediate solution is the localized one — the provision of wider surfaces at the points of most serious congestion. This does not mean, however, that emphasis should be removed from the other methods as a means of gradually improving the performance of motor trucks.

On the average, there is a 30-percent variation between the possible performance and the actual performance of vehicles in service. Since not over 10 percent of this variation should be due to lack of maintenance, there remains a 20-percent variation that must be charged to improper operation of the vehicle. In some cases the speed could have been doubled if the gears had been shifted at the proper engine speed. A considerable improvement in performance could be realized merely by instructing the driver as to the proper speeds at which to shift gears.

The performance of a motor vehicle may be computed by using the unit tractive resistances and efficiencies developed by this study, with a degree of accuracy not heretofore possible. Further research is necessary to determine the tractive resistance for higher speeds, for motor trucks with other types of bodies, and for various types of road surface.

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General Construction Machinery Advisory Committee Formed

The following men comprise the recently formed General Construction Machinery Advisory Committee of the Construction Machinery Branch of the Division of Industry Operations of the War Production Board:

Wm. Badger, Vice President, Bucyrus Erie Co., So. Milwaukee, Wisc.
H. G. Smith, Executive Engineer, Buda Co., Harvey, Ill.
J. F. Richardson, Secretary, Buffalo Springfield Roller Co., Springfield, O.
C. H. Frink, Owner, Carl H. Frink, Inc., Clayton, N. Y.
Ralph S. Boyd, Vice President, Galion Iron Wks. & Mfg. Co., Galion, O.
Neal Higgins, Govt. Sales Mgr., International Harvester Co., Chicago, Ill.
Howard Hall, President, Iowa Mfg. Co., Cedar Rapids, Iowa.
Henry Isaacson, President, Isaacson Iron Works, Seattle, Wash.
Lion Gardiner, Vice President, Jaeger Machine Co., Columbus, O.
Ed Galvin, Sales Mgr., R. G. Le Tourneau, Inc., Peoria, Ill.
John H. Jay, President, Quickway Truck Shovel, Inc., Denver, Colo.
Thorman W. Rosholt, President, Rosco Mfg. Co., Minneapolis, Minn.
Larry West, President, Simplicity Systems Co., Chattanooga, Tenn.
Chauncey B. Smythe, Vice President, Thew Shovel Co., Lorain, O.

About Contractors and Their Jobs

Kansas City Area

REPORTED BY
PAUL L. MATCHETTE

N. W. Hyland, Assistant Director of Public Works, Kansas City, Missouri, recently resigned this position to become associated as one of the Principal Engineers in the construction of the new $100,000,000 Ordnance Plant, now being built near a location approximately 25 miles west of Kansas City. Pat Hyland is one of the best construction engineers that the City of Kansas City, Missouri, has ever had in its employ.

* * *

Mr. Thomas H. Stryker, former Assistant Superintendent of Parks for Kansas City, Missouri, recently resigned this position. George M. Siemens, Jr., a well known contractor and builder in the city, has been appointed to this important position. Kansas City is outstanding in its parks and boulevards. The Department maintains over 100 miles of paved boulevards throughout the city. The general opinion of people not knowing Kansas City, think of it being built on the plains, stretching out over flat country.

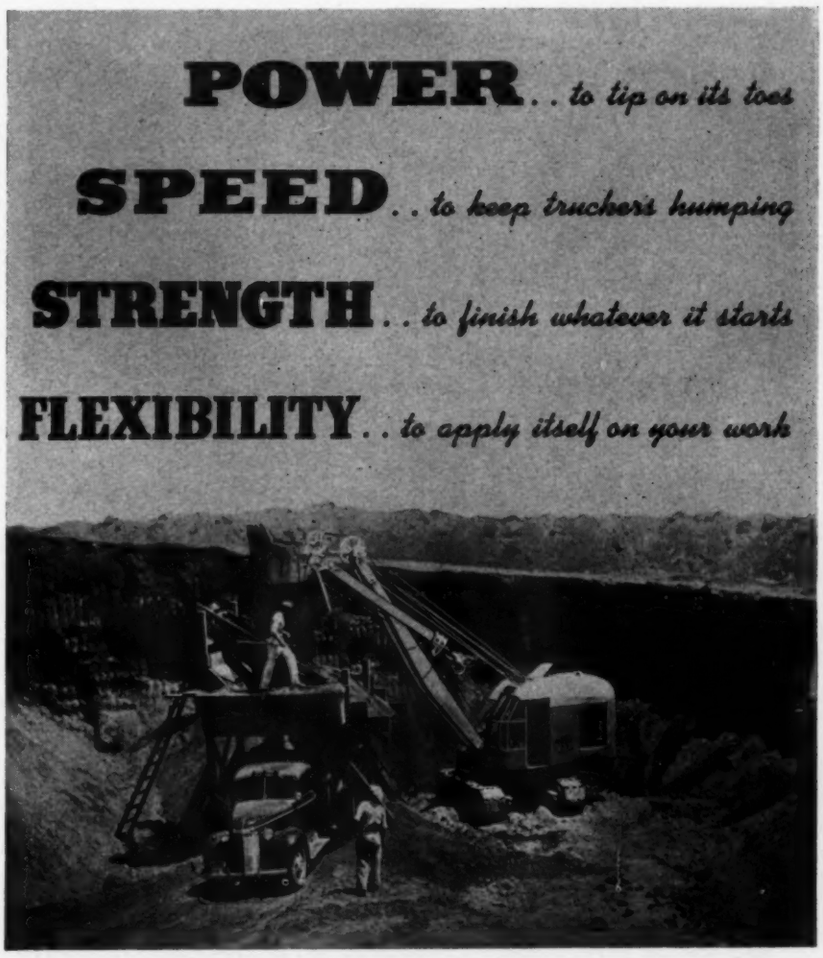
Greater Kansas City covers an area of 518 square miles. It is located at the junction of the Kansas and Missouri Rivers, on the boundary line between Missouri and Kansas, the larger portion, known as Kansas City, Missouri, lying in Missouri, south of the Missouri River. The topography is hilly and rolling. Both Kansas City, Missouri, and Kansas City, Kansas, have a wonderful system of boulevards and parks.

* * *

W. L. (Bill) Dyatt, Office Engineer of the Kansas State Highway Commission, Topeka, Kansas, holds a Senior Engineer rating in the Civil Service Branch of the Government. In the first World War, Bill served with the 30th Infantry, Third Division, which was entitled "Rock of the Marne."

Bill fought in the battles of the Aisne, the Champagne-Marne, the Aisne-Marne, the St. Mihiel and the Meuse-Argonne. Bill, also was on duty at Second Corps headquarters.

The other day, Uncle Sam sent Bill his Victory medal, with clasps, for the battles and sectors in which his unit was engaged. As office engineer, he has charge of all purchasing for the State Highway Commission. His position is one of the most important in the Highway Department. He has charge of the issuing of all specifications. This alone, is a big job in any Highway Department.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STRENGTH . . to finish whatever it starts
FLEXIBILITY . . to apply itself on your work

Balanced design, balanced weight and strength, balanced power and speed . . . these time tested features are proved in service and make possible Byers performance records.

This is another reason why you should investigate Byers excavators.

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The City of Kansas City, Missouri, recently asked for bids for paving material, street repair. Following are the items, low bidder, amount and the price bid.

Item	Low Bidder	Amount		Bid
MC-2 Cut back asphalt	Midwest Pre-Cote Company	80,000 gal.	@	$5.39
Special Cut back asphalt	Midwest Pre-Cote Company	150,000 gal.	@	7.57
Sheet asphalt	Midwest Pre-Cote Company	1,000 tons	@	7.15
Portland Cement concrete	Ready Mixed Company	1,000 Cu. yds.	@	7.13
Portland cement	Ready Mixed Company	6,800 sacks	@	.65
Kaw River sand	J. Shaw Coal and Material Co.	2,800 tons	@	1.00
Crushed limestone	Bethany Rock Company	6,000 tons	@	1.65

E. W. Geiger, Jr., son of E. W. Geiger, of Geiger and Rutherford, Road Contractors, Leavenworth, Kansas, has announced his engagement to Miss Lura Jane Smith. At the present time, he is a flight instructor at Lawrence, Kansas, where the University of Kansas is located.

* * *

Robert Major, until recently County Engineer for Greeley County, Kansas, has resigned that position and is now County Engineer for Wallace County, Kansas. Mr. Major is one of the most popular engineers in western Kansas. Wallace County is on the Colorado line, about half-way between Nebraska and Oklahoma. U. S. Highway No. 40 passes through Sharon Springs, the County Seat.

* * *

John Allison, Vice President of the Shallow Water Oil Refinery, located at Scott City, with headquarters at Garden City, Kansas, is running in the primaries for the nomination of United States Senator in competition to Arthur Capper, the present incumbent.

John lives at McPherson, Kansas. He is very active in oil. Many of the contractors obtain their asphalt from the Shallow Water Refinery, for the construction of black top roads in western Kansas. John Allison attended the University of Kansas and the University of Southern California. During the past 15 years he has been active in State civic affairs. This is his first venture into politics. He owns and operates several farms, has a keen business mind, and he is 40 years old. If successful in winning the nomination and election, it is felt that John will do a real job of representing the State of Kansas. With the knowledge that he has in both agriculture and the oil industry, the two outstanding products of the State, he will do a real job for his country in the United States Senate.

* * *

The Kansas Highway problem is a tough one, due to the reduction of revenue coming in from the gasoline tax. The Legislative Council, composed of a committee of men now working on the problem, are working with the view of preparing some kind of a bill for the next Legislature to make the handling of road funds more flexible. With the use of gasoline already curtailed, and with the threat of rationing on top of this, the situation is a tough one.

The Kansas State Highway funds are largely fixed. Of the $14,000,000 normally received each year, about $11,000,000 is ear-marked before any money can be applied on the building of new roads. Of the $11,000,000, a total of $3,600,000 goes to counties, where both county and township roads are taken care of from this. $1,000,000 goes to the payment of benefit districts. Municipalities receive money for maintenance of city streets, used as highway lengths. A certain amount of money is appropriated each year to take care of the ports of entry and the highway patrol.

About $5,000,000 is set aside for maintenance and other expenses, such as administration, etc., makes up the

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SCHRAMM Air Compressors are gasoline, diesel or electric powered and range in size from the 20 to the 420 cu. ft. actual air capacity. They are LIGHT IN WEIGHT, SELF-STARTING, HAVE AN ECONOMICAL SPEED, FORCE FEED LUBRICATION AND AUTOMATIC CONTROLS.

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balance. There are millions of dollars to be paid back to benefit districts for construction of highways that were built before the present laws went into effect. The State has set aside $1,000,000 a year to be taken from the highway funds to pay these old claims. If gasoline is rationed in Kansas, it will be a serious blow to the highways of Kansas.

* * *

William R. Wooten, City Engineer of the City of Tulsa, Oklahoma, President of the Oklahoma Society of Professional Engineers, is considered one of the outstanding men in his profession, throughout the Southwest. The Society is very active in all construction problems of the State, and is fortunate to have a man of Bill Wooten's high standing. The City of Tulsa is outstanding in its utilities.

To one who has never been in Tulsa, they cannot appreciate what a beautiful city it is. It is located in northeastern Oklahoma, on the Arkansas River, and is known as the oil center of the Country, where most of the operating oil companies of the Mid-Continent field have their headquarters. The roads and streets are as well, if not better kept, than any other city in the Southwest.

Bill Wooten is a quiet-spoken man. When he starts out to do something, he gets it done. Paul Gulley, Assistant Engineer, and Preston Ligon, are able assistants and are a credit to their community.

* * *

May 19th the Oklahoma State Highway Commission took bids on the construction of 21 new State Highway projects. Below are the total estimates made by the Highway Department; the total low bids and the bids that were submitted above the estimates.

Total Estimates	$1,498,926.12
Total Low Bids	1,755,126.51
Bids above Estimates	256,200.39

Due to the shortage of equipment, and certain materials; and the shortage of certain labor, the contractors are having difficulty in figuring their costs in certain sections. Compared with other State bids and with Government bids that have been received recently, these State Highway figures are in line. In fact, the average is a little better than in most localities.

* * *

Slim Dahlgren, Rusty Ryan, Sewell Beekman and Bert Brooks have formed the company of Dahlgren, Ryan, Beekman and Brooks, with offices in 424 Insurance Building, Oklahoma City, Oklahoma. They were the successful bidders and are now building the new Navy Super Airport, at Norman, Oklahoma.

The combination of these four men is an excellent one. Slim Dahlgren is one of the hardest and fastest construction men in the paving industry. By hardest and fastest, we mean the hardest and fastest worker. To get the job done on time, Slim does not hesitate to work 24 hours a day. He has the most loyal bunch of men working with him that we know of.

Rusty Ryan is an outstanding engineer and construction man. He has laid down as much, if not more, miles of road in Oklahoma and Kansas, than any other man in the business. As an operator, he is par excellent.

Sewell Beekman is an attorney of wide acquaintance. He knows the law in regard to construction, from A to Z, and is considered, and is, the best authority on paving construction in the State of Oklahoma.

Bert Brooks is a financial wizard. For the past 30 years, he has handled the financing of construction work in Oklahoma. Bert Brooks does exactly as he says he will do. His word is as good as his bond.

The combination of these four men is exceptional. The Navy is fortunate in having them doing the work at Norman. We predict the job will be done ahead of schedule.

One glance at the photo above tells a story of smooth-working efficiency on this big southeastern airport — typical of airport and access road jobs throughout the country being cured with SISALKRAFT. Saves Time — Man-power — Money. Only two men are required to unroll SISALKRAFT blankets, directly behind the finishers. Original mixing water held in . . . curing is automatic . . . no sprinkling at any time. Efficient . . . Foolproof . . . Smooth!

Blankets are re-used time after time — cut curing costs down to the bone — free man-power for other jobs. Keep work rolling on schedule. SISALKRAFT curing is in the Specifications of 42 State Highway Departments and on defense jobs in every section of the country and the outer island groups. Rolls, covers and blankets available in sizes to fit any job. Write for data, samples, and details of our on-the-job service. Distribution Everywhere.

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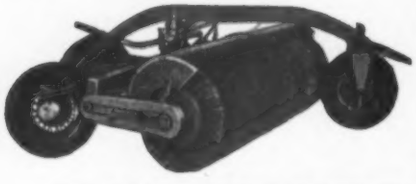

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- *Grace 2-Way Axle Driven Sweeper*—the modern traction driven sweeper that successfully meets the sweeping problem of any contractor.
- *Rapid Fire Heater*—A fast-pumping, fast-heat circulating heater that heats 10,000-gallon insulated cars at 40-50° per hour. Write for information and prices.

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WITH THE MANUFACTURERS

McClure Kelley Succeeds Samuel F. Beatty

McClure Kelley, who began his association with the company in 1929 as assistant treasurer, becoming treasurer in 1931 and vice-president and treasurer in 1940, has been elected president of The Austin - Western Road Machinery Co. of Aurora, Ill., by the board of directors. Mr. Kelley succeeds to the office on Aug. 1, at which time Samuel F. Beatty will become chairman of the executive committee. Mr. Beatty has been associated with the company for 43 years, the last 15 years as president.

McClure Kelley

C. N. Barney Elected Worthington Vice President

The board of directors of Worthington Pump and Machinery Corporation has elected Charles Neal Barney of Scarsdale, N. Y., a vice-president of the corporation. A member of the Worthington organization from 1918, he has been treasurer since 1931, as well as the head of the corporation's legal department. Mr. Barney formerly practiced law in Massachusetts and was a lecturer at Northeastern Law School and Boston University Law School. He is a member of the American, Massachusetts and New York, Bar Associations, author of the law text "Equity and Its Remedies" and was, early in his career, Mayor of Lynn, Mass. He is a member of the Society of Mayflower Descendants (N. Y.); the University Club (N. Y.) and Fox Meadow Tennis Club, Scarsdale, N. Y.

Timber Engineering Co. Opens Portland Office

Timber Engineering Co., Inc., of Washington, D. C., has opened a branch office in the Yeon Bldg., Portland, Ore. Establishment of the office has been occasioned by increased building of war projects which has brought a growing demand from engineers and architects for technical information.

The new branch is to assist distributors and timber fabricators in the northwest in their promotion of timber construction, render technical advisory service, maintain additional stocks of Teco products readily at hand, co-operate with the West Coast Lumbermen's Association and the Western Pine Association in lumber promotion activities, and do educational work with engineering students and practicing engineers.

The Portland office will be under the general direction of J. E. Mackie, formerly of Portland, who is now manager of the San Francisco office of the National Lumber Manufacturers' Association.

In direct charge of the office is Alden K. Smith, formerly assistant technical director of the National Lumber Manufacturers' Association. A product of Colgate and George Washington Universities, Mr. Smith was born in Berkeley, Calif., and gained west coast business experience with Western Timber Structures, Inc., and the Timber Engineering Co. of California, both of San Francisco.

Ellzey Brown Now in Army

Wiley Ellzey Brown, Vice President and General Sales Manager of The Cleveland Tractor Co., has been granted an indefinite leave of absence to join the Army of the United States. He has been called to active duty as a major and reported for active duty at the Ordnance Training Center, Aberdeen Proving Grounds, Aberdeen, Maryland, April 25. Major Brown has been associated with The Cleveland Tractor Co. for the last three years. Previous to his Cleveland connection he was also engaged in sales and management activities in the tractor industry for a considerable period of time.

Ellzey Brown

Equipment Corporation of America Expands

The Equipment Corporation of America has just undergone further expansion by the purchase of a 250 ft. brick building adjacent to their present properties in Chicago. This addition was made necessary by the great demand for rebuilt construction equipment occasioned by the large government building program in connection with war industries. The newly acquired building was purchased from the Allis-Chalmers Manufacturing Co. by H. M. Capron, president of the Equipment Corporation of America. It will be used to house much of the rebuilt construc-

tion equipment and will thus provide additional space in their main plant for rebuilding operations. In addition to the Chicago facilities, the Equipment Corporation of America owns and operates rebuilding plants in Philadelphia and Pittsburgh. This is the second part of an expansion program brought about by war needs. The first step was taken during the past year by the opening of an office in New York City.

Dr. Pechukas Made Acting Director of Research for Columbia Chemical

Alfonse Pechukas has been named Acting Director of Research of the Columbia Chemical Division of the Pittsburgh Plate Glass Co., succeeding Dr. Irving E. Muskat, resigned. Dr. Pechukas, whose headquarters are at Barberton, Ohio, has been associated with the company for the past five years. He holds degrees of B.S. and Ph.D. from the University of Chicago.

Spain and McDonald Promoted by Caterpillar Tractor Co.

Appointment of Gail E. Spain to the position of vice-president, and the promotion of John Q. McDonald to general sales manager, has been announced by Caterpillar Tractor Co., Peoria, Ill. Mr. Spain, who has been general sales manager since November, 1940, succeeds the late D. G. Sherwin and will move to "Caterpillar's" San Leandro, Calif., office to direct activities there and coordinate operations with those in Peoria. Mr. Spain is a native of Portland, Ore. He was graduated from Oregon State College in 1920 with the degree of mechanical engineer. After his graduation, Mr. Spain joined the Willamette Iron & Steel Works at Portland, Ore., and spent nine years with that organization in the sales and engineering departments. For two years before coming to "Caterpillar," Mr. Spain was Willamette's sales manager. Mr. Spain jointed Caterpillar Tractor Co. at San Leandro in 1929 and was transferred to Peoria the same year. He has held, progressively, the positions of logging representative, assistant manager merchandise department, assistant manager engine sales division, assistant sales manager, manager sales development division and general sales manager. He also served one year with Sullivan Machinery Co. as General Manager of the rock handling division. Mr. McDonald has served as export sales manager since May, 1940. A native of Lompoc, Calif., and a graduate of the University of California, he served throughout World War I commissioned as a pilot in the U. S. Army Aviation Corps. In 1927 he joined "Caterpillar" as supervisor of agricultural sales for the western United States and the western part of Canada. In 1929 he went to Europe to study the applications of "Caterpillar" track-type tractors in Russia. Returning to this country in 1930, Mr. McDonald served for four years as district representative for the company in various parts of the country. In 1934 he became the company's district representative in London and countries in northern Europe, returning two years later to Peoria to serve as export sales supervisor and assistant export sales manager before his promotion to export sales manager. J. D. Fletcher Vice President, will take over the active direction of export sales in addition to his duties as head of the export department. The board of directors of "Caterpillar," besides elevating Mr. Spain to vice-presidency, took action to place on the board C. O. G. Miller of San Francisco, Calif., to fill the vacancy left by the recent death of John A. McGregor. Mr. Miller is a director also of the Pacific Gas and Electric Co., Pacific Lighting Corporation, Soundview Pulp and Paper Co. and Coos Bay Lumber Co. and is recognized as one of the outstanding business men of the country.

G. E. Spain

J. Q. McDonald

Chart for Axle Inspections

The Timken-Detroit Axle Co., Detroit, Mich., has issued a new 22 in. x 38 in. wall chart describing axle inspections which should be made at regular intervals in carrying out a well-rounded truck maintenance program. The new wall chart is one of many similar maintenance aids produced by the company in connection with its A. M. (Axle Maintenance) Program launched the first of this year. In addition to covering front

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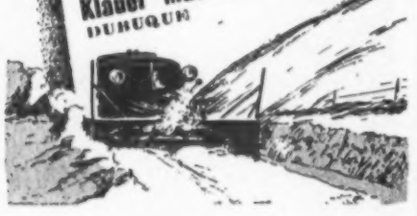

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axles and the four types of rear driving axles the company manufactures —bevel, worm, double reduction and two speed double reduction — the chart also describes inspection operations applying to brakes and transfer cases. All types of equipment covered by the wall chart are illustrated to assure clear understanding of the inspection instructions given. The new wall chart is attractively printed in two colors and is designed to be hung in offices as well as in shops. The top and bottom edges are reinforced with metal strips, while a metal eyelet is provided at the top to permit hanging the chart in any convenient wall location. Copies of the wall chart may be secured without charge by addressing the Timken service department at the main plant in Detroit, Mich.

Dewey Elected A Vice President

G. A. Bassett, President, Gar Wood Industries, Inc., Detroit, Mich., has announced that Frank H. Dewey, General Manager of the Gar Wood Air Conditioning Division, has been elected a vice president of the company. Mr. Dewey will continue his duties as general manager of the Air Conditioning Division.

Acme Road Machinery Co. Resumes Business

Acme Road Machinery Co., Frankfort, N. Y., has again opened business based on patents, drawings and good will which were purchased from the Dallas Winslow Co. of Detroit. The new company will be under the management of David B. Cook, Jr. This company formerly made road rollers and rock crushers.

Robert Gilmore Is Dead

Robert Gilmore, 63, General Manager of the Wire Rope Division of the Jones & Laughlin Steel Corporation at Muncy, Pa., died May 14 after a heart attack. Mr. Gilmore had been associated with the wire rope industry for the past 50 years and started with Jones & Laughlin in July, 1938. He was a pioneer in the development of wire rope and was widely known throughout the industry.

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R. W. Miller Appointed Manager Technical Service Department Columbia Chemical

R. W. Miller, who has been connected with the Pittsburgh Plate Glass Co. for 12 years, has been appointed manager of the technical service department of the company's Columbia Chemical Division. Mr. Miller has been engaged in technical service activities since 1937, and succeeds Dr. G. L. Cunningham who has resigned. He joined the company in 1930 after receiving a B.S. degree in chemistry at Pennsylvania State College. After three years in the Research Department on pilot plant operations and general investigation. Mr. Miller was assigned to study on the uses of calcium chloride in soils for engineering purposes. He was active in promoting the principles of soil stabilization. Since 1937 he has assisted customers in application of alkalies and chlorine.

R. W. Miller

Hercules Powder Co. Promotions

Hercules Powder Co., on May 22, announced the appointment, effective June 1, 1942, of William J. Austin, manager of the Chicago, Ill., office of the Explosives Department, as director of purchases of the company. Mr. Austin succeeds Kurt W. Jappe, former director of purchases, who will become manager of detonator operations, Explosives Department. Frank W. Roman, assistant manager of the Chicago office of the Explosives Department, will replace Mr. Austin as manager of that office.

Kotal Appoints Union Building & Construction Corp. as Distributor

The Kotal Co. of New York City has announced the appointment of the Union Building & Construction Corporation of Passaic, N. J., as a distributor for Kotal, the waterproofing compound used in bituminous maintenance and construction. This firm, one of the largest in the state of New Jersey, is headed by Dow Drukker, who is personally directing the sale of Kotal, Kotal treated aggregate and Kotal asphalt mixes in this state. The Kotal Co. is now represented by twelve distributors doing an active business east of the Rocky Mountains.

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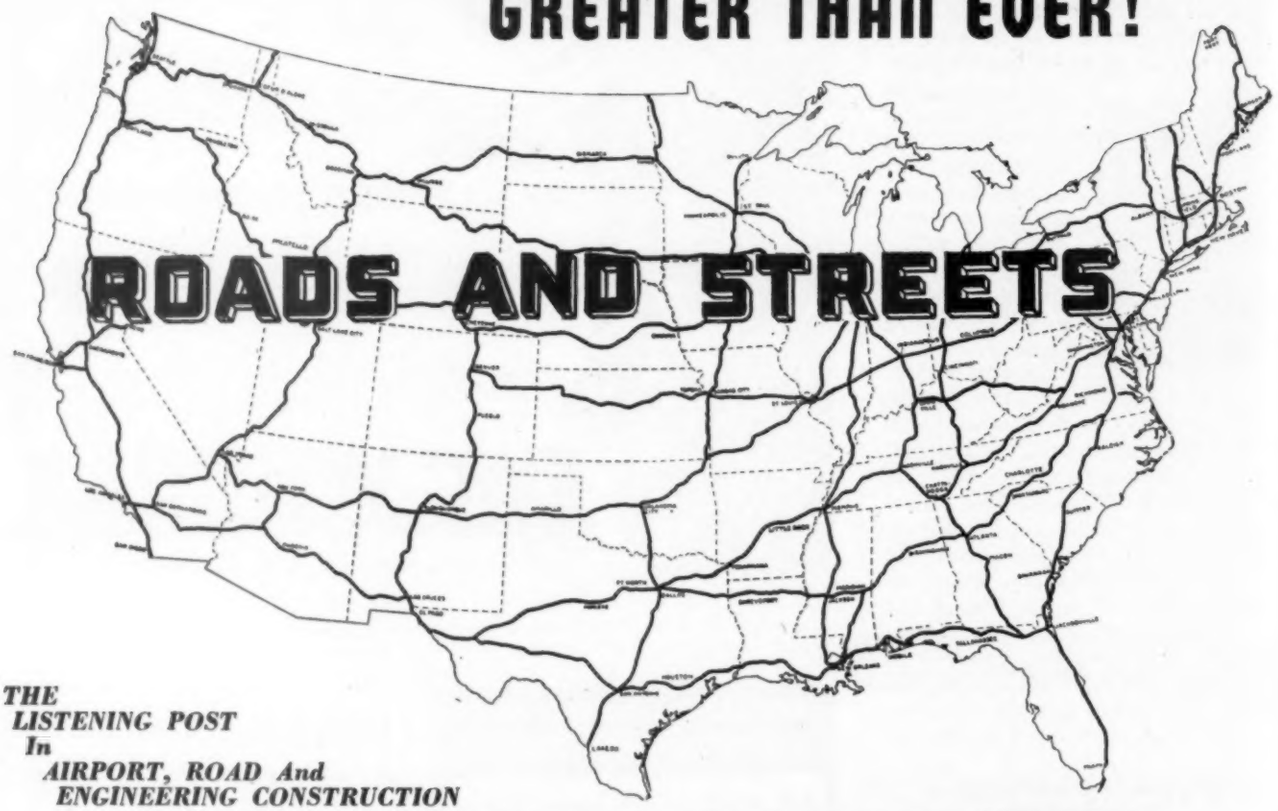

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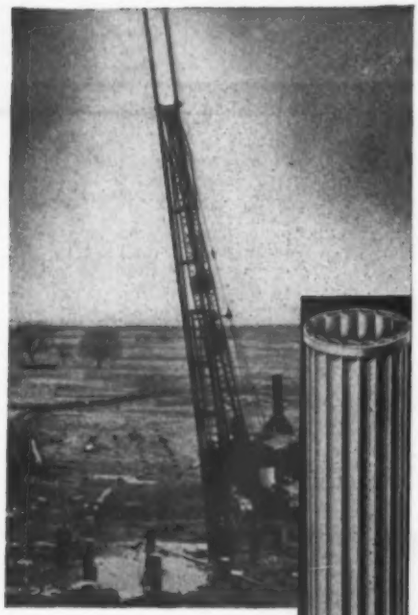

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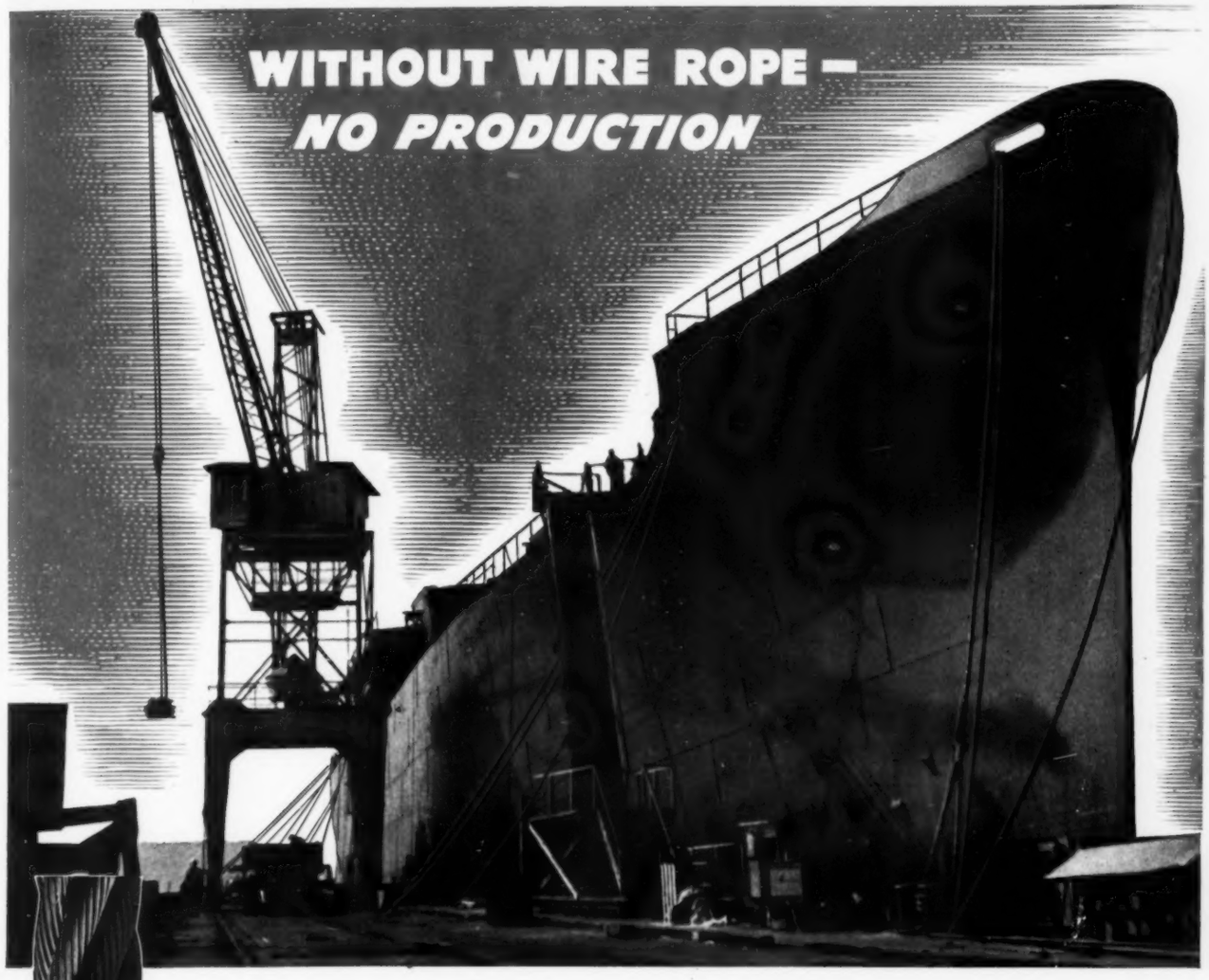

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